ARIZONA DEPARTMENT OF TRANSPORTATION

REPORT NUMBER: FHWA-AZ92-379-II

SPS-6: REHABILITATION OF JOINTED PORTLAND CEMENT CONCRETE PAVEMENTS

Construction Report

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November 1992

Prepared for:
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in cooperation with
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Federal Highway Administration

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16. Abstract

Nineteen test sections were constructed by the Arizona Department of Transportation (ADOT) as part of Strategic Highway Research Program (SHRP) Specific Pavement Studies (SPS)-6 experiment. The SPS-6 program addresses the rehabilitation of jointed portland cement concrete pavement. The objective of the SPS-6 experiment is to develop improved performance prediction models to be used for determining the additional pavement life that can be expected from the application of a variety of JCP pavement rehabilitation methods, ranging from minimal to maximum investment.

Construction of the 19 SPS-6 test sections was successfully incorporated in ADOT project IR-40-4(123) on I-40 at Flagstaff. Eight of the 19 test sections meet the basic SHRP requirements for the experiment. The additional 11 sections were designed by ADOT to evaluate features that are not included in the SHRP experiment design. The 8 SHRP sections include 3 different types of surface preparation of the existing JCP 1)crack and seat, 2) minimum restoration, and 3) maximum restoration. They also include two different asphalt overlay thicknesses - 4" and 8", two sections with no overlay, and one control section which is to receive only routine ADOT maintenance. The 11 ADOT sections include an additional surface preparation procedure - rubblizing the existing JCP - as well as an unbonded JCP overlay, asphalt overlay with fabric, various thickness combinations of asphalt rubber and conventional asphalt overlays, and asphalt rubber asphalt concrete friction course. The 19 test sections were constructed in an approximate 2.6 mile segment of the 10 mile long I-40 rehabilitation project. Average test section length is 500'. Design and construction data from these sections, along with future performance data, will be an important contribution to achieving the goals of the SPS-6 program.

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METRIC (SI*) CONVERSION FACTORS

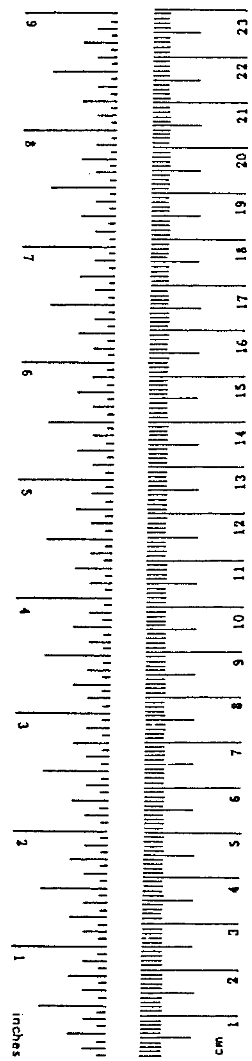
APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
	LENGTH			
in	inches	2.54	centimetres	cm
ft	feet	0.3048	metres	m
yd	yards	0.914	metres	m
mi	miles	1.61	kilometres	km
	AREA			
in^2	square inches	645.2	centimetres squared	cm^2
ft^2	square feet	0.0929	metres squared	m^2
yd^2	square yards	0.836	metres squared	m^2
mi^2	square miles	2.59	kilometres squared	km^2
ac	acres	0.395	hectares	ha
	MASS (weight)			
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg
	VOLUME			
fl oz	fluid ounces	29.57	millilitres	mL
gal	gallons	3.785	litres	L
ft^3	cubic feet	0.0328	metres cubed	m^3
yd^3	cubic yards	0.0765	metres cubed	m^3

NOTE: Volumes greater than 1000 L shall be shown in m^3.

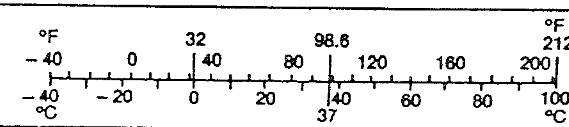
Symbol	When You Know	Multiply By	To Find	Symbol
	TEMPERATURE (exact)			
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

* SI is the symbol for the International System of Measurements



APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
	LENGTH			
mm	millimetres	0.039	inches	in
m	metres	3.28	feet	ft
m	metres	1.09	yards	yd
km	kilometres	0.621	miles	mi
	AREA			
mm^2	millimetres squared	0.0016	square inches	in^2
m^2	metres squared	10.764	square feet	ft^2
km^2	kilometres squared	0.39	square miles	mi^2
ha	hectores (10 000 m^2)	2.53	acres	ac
	MASS (weight)			
g	grams	0.0353	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams (1 000 kg)	1.103	short tons	T
	VOLUME			
mL	millilitres	0.034	fluid ounces	fl oz
L	litres	0.264	gallons	gal
m^3	metres cubed	35.315	cubic feet	ft^3
m^3	metres cubed	1.308	cubic yards	yd^3
	TEMPERATURE (exact)			
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



These factors conform to the requirement of FHWA Order 5190.1A.

EXECUTIVE SUMMARY

Nineteen test sections were constructed by the Arizona Department of Transportation (ADOT) as part of Strategic Highway Research Program (SHRP) Specific Pavement Studies (SPS) -6 experiment. The SPS-6 program addresses the rehabilitation of jointed portland cement concrete pavement. The objective of the SPS-6 experiment is to develop improved performance prediction models to be used for determining the additional pavement life that can be expected from the application of a variety of JCP and JRCP pavement rehabilitation methods and strategies, ranging from minimal to maximum investment in the rehabilitation treatment. The test sections in this ADOT project deal with JCP only.

EXPERIMENTAL FEATURES

Eight of the nineteen test sections meet the basic SHRP requirements for the experiment. The additional eleven sections were designed by ADOT to evaluate features that are not included in the SHRP experiment design.

The 8 SHRP sections include 3 different types of surface preparation of the existing JCP - 1) crack and seat, 2) minimum restoration, and 3) maximum restoration. They also include two different conventional asphalt overlay thicknesses - 4" and 8", two sections with no overlay, and one control section which is to receive only routine ADOT maintenance procedures.

The 11 ADOT sections include an additional surface preparation procedure - rubblizing the existing JCP - as well as an unbonded JCP overlay, asphalt overlay with fabric, various thickness combinations of asphalt rubber and conventional asphalt overlays, and asphalt rubber asphalt concrete friction course.

EXISTING PROJECT DESCRIPTION

The test sections were incorporated in ADOT construction project IR-40-4(123) on I-40 at Flagstaff, which extends from U.S. 89A (MP 195) to the Walnut Canyon Interchange (MP 205) in the eastbound direction. Total project length is 10 miles.

The existing pavement is a 38' roadway, consisting of two 12' travel lanes, a 10' outside shoulder and 4' inside shoulder. Travel lanes are 8" to 9" thick JCP and the shoulders are 2.5" to 3" AC. ADT ranges from 4,000 to 8,000, depending on the time of year. Truck average speed is 61 to 64 mph.

Pavement distress in the outside lane of the existing JCP consists of joint and crack spalling, longitudinal, transverse, and random direction cracking, and shattered slabs. Approximately 80% - 90% of the slabs exhibit some type of distress. Approximately 50% of the joints have spalling, 35% to 40% have longitudinal/transverse cracking, and 5% to 15% of the slabs are shattered (broken into 3 or more pieces).

CONSTRUCTION PROJECT DESCRIPTION

All the SHRP test sections were designed following the ideas in the SHRP "Specific Pavement Studies Experimental Design and Research Plan for Experiment SPS-6, Rehabilitation of Jointed Portland Cement Concrete Pavements." The SHRP guidelines for construction details "Construction Guidelines for Experiment SPS-6, Rehabilitation of Jointed Portland Cement Concrete Pavements" were followed as closely as possible in construction.

Repairs and other activities on the control section were limited by SHRP to only routine maintenance needed to keep the section in a safe and functional condition. In general, the maintenance activities were required to be limited to those permitted in SHRP "Guidelines for Maintenance of General Pavement Studies (GPS) Test Sections."

The minimum level of pavement restoration includes joint and crack sealing, partial and full-depth patching, and full surface diamond grinding. The maximum level of restoration includes removing and replacing existing joint and crack sealing, performing additional joint and crack sealing, removing and replacing existing partial and full-depth patching, performing additional partial and full-depth patching, correcting poor load transfer at joints, full surface diamond grinding, retrofitting subsurface edge drains, and undersealing. These activities were to be performed only if warranted.

The crack and seat procedure for the SHRP sections was intended to produce a nominal crack spacing of 3' x 3'. The pavement was then rolled until the broken pieces were seated. Crack and seat on some of the ADOT sections was intended to produce a 4' x 6' cracking pattern. A tack coat was to be placed prior to overlay.

The rubblizing procedure on the ADOT sections was intended to break the pavement into nominal 1" to 2" pieces. It was then to be compacted with a vibratory roller and primed prior to overlay with asphaltic concrete.

Sections to receive 4" overlays were placed in two 2" lifts, the 8" overlay was placed in two 3" and one 2" lift, and 5" overlays were placed in one 3" and one 2" lift. Tack coats were applied between lifts. The unbonded PCC overlay in ADOT Section 2 was poured on 2" of asphalt concrete.

The asphalt concrete friction course (ACFC) was intended to be 5/8" thick on some of the sections (the SHRP limit is 0.75"), and the asphalt rubber asphalt concrete friction course (AR-ACFC) was intended to be 0.50" thick on the additional ADOT sections.

The design of asphalt concrete mixes were specified to be done in compliance with guidelines in FHWA Technical Advisory T-5040.27. Only virgin aggregates are allowed and they are expected to be of highest quality. Asphalt cement was to be selected by ADOT based on normal practice. No deviations from SHRP design and construction guidelines were allowed unless accepted by SHRP.

CHARACTERISTICS OF MATERIALS

The virgin asphalt concrete mix design was a 3/4" mix consisting of basalt coarse aggregate, basalt intermediate aggregate, basalt fine aggregate, Flagstaff cinders, Mahan concrete sand, and Winslow sand. Asphalt cement was AC-20 at 4.6% by weight of mix. Mineral admixture was hydrated lime at 1.5% by weight of aggregate.

The asphalt rubber asphalt concrete mix design included 20% granulated rubber of Type C 106 and AC-10 asphalt cement. Bituminous content was 6.5% by weight of mix. The mineral admixture was lime, used at a rate of 1% by weight of aggregate.

The asphalt concrete friction course (ACFC) consisted of 90% 3/8" aggregate, 4% CR Fines, 6% W-Fines, and 6.8% AC-20.

Spall repair material was CALTRANS Formula SET 45, a rapid setting patch material, with 25 lbs of rock per bag of SET 45. A 3/4" maximum size aggregate was used.

Concrete for the full-depth repairs and unbonded overlay complied with ADOT specification 1006. A Class P 4,000 psi concrete was specified. Cement was Type II Low Alkali and fly ash was Class F. Entrained air was specified to be 4% to 7%, and slump 2.5" to 4.5". Aggregate size was specified as 1.5" maximum. Actual gradation used was 1" maximum. A wax based curing compound was used. Concrete joint sealant was a silicone.

CONSTRUCTION OVERVIEW

The nineteen test sections were constructed in an approximate 2.6 mile segment of the 10 mile long I-40 rehabilitation project. Average test section length is approximately 500', excluding transitions between sections.

The test sections were constructed between mid-June and mid-October of 1990. Efforts from mid-June through the end of July concentrated primarily on minimum and maximum surface preparations and the trench drain. Crack and seat and rubblizing was done from August 1 through August 5 and the bulk of the asphalt paving was from August 5 through August 12. The unbonded PCC overlay was placed on September 4 in the passing lane and September 24 in the travel lane. The ACFC and AR-ACFC were placed in mid-October.

Crack and seat was accomplished with a guillotine type pavement breaker and seating was done with one pass of a 50 ton roller. For the rubblized sections a PB4 resonant breaker was used in longitudinal passes approximately 7" to 12" wide with a steel shoe using a 2,000 lb force at 44 times/minute.

The asphalt concrete mix was produced in a drum mixer plant and placed in typical 12' wide lanes. Breakdown rolling was one pass of a 12.5 ton double drum vibratory roller. Intermediate rolling was 4 passes of a pneumatic. Finish rolling was one pass of a 12.5 ton vibratory and two passes of a 12.5 ton static roller. Tack coat was an SS-1H applied at .08 gal/SY.

Tests run on the construction materials indicate they were in compliance with the specifications. Asphalt content ranged from 4.5% to 4.9%. Air voids ranged from 3.9% to 5.1% and stability was generally between 3,000 and 4,000.

The portland cement concrete 28-day average compressive strength ranged from 4,400 to 5,100 psi, with air entrainment average from 5.2% to 5.5%. Slump was in the average range of 3.6" to 4.6"

CONCLUSIONS

Design and construction of the SPS-6 test sections were successfully incorporated in ADOT construction project IR-40-4(123) on I-40 at Flagstaff. All features of the SHRP required SPS-6 experiment design were included in eight basic test sections. Design and construction data from these sections, along with future performance data that will be collected, will be a meaningful and important contribution to achieving the goals of the SPS-6 program.

In addition to the eight required SHRP sections, ADOT included eleven more test sections which were designed to incorporate features that are not in the SHRP SPS-6 experiment design. Continued study of these sections will provide valuable input to ADOT in its desires to develop the most effective and economical types of pavement design and construction for rehabilitation of jointed PCC pavements.

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I. INTRODUCTION

GENERAL

As the nation's highway infrastructure is growing older, reconstruction and rehabilitation of the vast road network have become increasingly important. Today, a major share of highway funds is being used up in maintenance, rehabilitation and reconstruction of the pavements. In 1985, it was estimated that four hundred billion dollars will be spent on replacing and rehabilitating existing pavements around the nation over the next fifteen years (2). The costs to the road users of poor pavement conditions will probably be several times this amount in the same period. The Strategic Highway Research Program (SHRP), a five year, $150 million result oriented research effort was initiated in 1987 in order to cope with the rapidly deteriorating highway infrastructure of the nation. The program was authorized by the U.S. Congress with the passage of the Surface Transportation and Urban Relocation Act in 1987. SHRP is a highly focused research program directed at four specific technical areas: Pavement Performance, Asphalt, Highway Operation, and Concrete and Structures. Research in Pavement Performance is being conducted by SHRP and SHRP contractors in cooperation with the States and the Federal Highway Administration. Although current funding for this research is for five years, the program is designed as a twenty year program. As such it has been named the Long Term Pavement Performance (LTPP) Study.

SHRP's LTPP program is designed to develop better and longer lasting pavements. To accomplish this SHRP will test and evaluate approximately 800 in-service pavements and 1100 newly surfaced pavements constructed as test sections. The LTPP program will evaluate pavement performance over a broad range of materials, pavement types, climates, traffic loadings, subbase, and pavement ages. The LTPP program is focused on two major areas of study. The first study area which evaluates the performance of existing pavements is known as the General Pavement Studies (GPS). The second area which investigates the performance of pavements constructed as part of an experiment is the Specific Pavement Studies (SPS). The SPS projects are aimed at attaining LTPP objectives which cannot be completely met by the GPS studies, simply because existing pavement sections do not provide all the necessary comparisons to evaluate the dominant factors in pavement distress and performance. With greater experimental control, SPS can provide much more precise answers for pavement design and performance prediction. The SPS program presently consists of seven programs grouped into three categories. It will eventually consist of ten programs grouped into five categories as shown below:

CURRENT:

Structural Factors:

SPS-1: Strategic Study of Structural Factors for A.C. Pavements

SPS-2: Strategic Study of Structural Factors for Concrete Pavements

Pavement Maintenance:

SPS-3: Preventative Maintenance Effectiveness of Flexible Pavements

SPS-4: Preventative Maintenance Effectiveness of Rigid Pavements

Pavement Rehabilitation:

SPS-5: Rehabilitation of Asphalt Concrete Pavements

SPS-6: Rehabilitation of Jointed Portland Cement Concrete Pavements

SPS-7: Bonded Concrete Overlays of Concrete Pavements

FUTURE:

Environmental Effects:

SPS-8: Study of Environmental Effects in the Absence of Heavy Loads

Materials Validation Testing:

SPS-9: Asphalt Concrete Materials

SPS-10: Portland Cement Concrete Materials

This report discusses the construction of test sections for SPS-6: Rehabilitation of Jointed Portland Cement Concrete Pavements.

The experimental designs and research plans (3) for SPS-6 were adapted from the Specific Pavement Studies on restoration of jointed concrete pavements (JCP) and pretreated JCP with AC overlay originally described in the May 1986 Strategic Highway Research Program Research Plans issued by the Transportation Research Board. Some of the original experimental design factors have been revised based on state and province desires and budget limitations. This research plan was to be used by highway agencies and SHRP as a guide for selecting candidate projects to be considered for inclusion in the SPS-6 experiment and for design and construction of the test sections.

PROBLEM STATEMENT

Many United States and Canadian highway agencies are faced with the difficult task of determining the best way to treat existing aging and deteriorating jointed concrete pavements. Not only must they determine which rehabilitation procedures work best under which circumstances, but they must also determine the most appropriate time to apply such rehabilitation treatments. The problem is further complicated by the need to address an entire network of pavements at various levels of condition and age with limited funding resources.

There are a variety of rehabilitation techniques that can be applied to jointed concrete pavements (JCP) to restore condition and extend service life. These techniques involve a combination of levels and types of pavement preparation with and without the application of asphalt concrete (AC) overlays.

Pavement preparation approaches range from minimal treatment of the original PCC pavement to full "Concrete Pavement Restoration" (CPR) as well as cracking/breaking and seating. Pavement preparation can include diamond grinding, subsealing, full-depth repair, partial-depth spall repair, restoration of load transfer, resealing of transverse joints, resealing of longitudinal lane/shoulder joints, pressure relief joints, retrofit tied PCC concrete shoulders, and longitudinal subdrains. Depending on the extent and type of pavement preparation, asphalt concrete overlays of appropriate thicknesses may or may not be applied.

The long term performance of such rehabilitated pavements has not been systematically monitored and evaluated. There are no analytical design procedures for PCC rehabilitation and there are many unanswered questions regarding the appropriate rehabilitation techniques to use for a given pavement condition, traffic level, and climate as well as the proper timing of rehabilitation treatments.

One of the major LTPP objectives is "To Develop Improved Design Methodologies and Strategies for the Rehabilitation of Existing Pavements." A generally accepted approach for making cost effective decisions on pavement maintenance and rehabilitation is the use of pavement management concepts including life-cycle cost analyses of construction and rehabilitation activities. The ability to predict the performance and life expectancy of various rehabilitation strategies, with and without overlays, is essential to pavement management and life-cycle cost analyses. Consequently, the development of improved performance predictions models for various rehabilitation strategies is essential to achieving the LTPP objectives and should be one of the early products of research.

OBJECTIVE

The objective of the SPS-6 experiment is to develop improved performance prediction models to be used for determining the additional pavement life that can be expected from the application of a variety of JPC and JRC pavement rehabilitation methods and strategies ranging from minimal to maximum investment in the rehabilitation treatment. The treatments being studied include combinations of surface preparations, with and without AC overlay, as well as crack and seat preparation with AC overlay. The study objective includes a determination of the influence of environmental region and initial pavement condition on the effectiveness of rehabilitation methods. Accomplishing this objective will provide substantially improved "tools" for use in pavement management and life-cycle cost analysis activities.

II. DESCRIPTION OF SPS-6 EXPERIMENT

INTRODUCTION

This experiment design is a coordinated research plan intended to produce data and performance information for a variety of rehabilitation and overlay procedures constructed to extend the life of existing jointed PCC pavements. The primary factors being studied are: (1) the extent of preparation and restoration of the existing pavement, (2) thickness of AC overlay, and (3) environmental (climatic) factors. Other considerations are: (1) existing condition of pavement, (2) pavement type, (3) subgrade soil, and (4) traffic volume and load. In addition, the experiment includes other test sections desired by ADOT to evaluate local practices or innovative features. These include PCC overlay, asphalt rubber AC, and variations in surface preparation.

EXPERIMENT DESIGN

The SHRP recommended experiment design is shown in Table 1. It identifies the primary experimental factors and their relationships with each other. Table 1 identifies site related factors across the top and rehabilitation treatments down the side. Each column in this arrangement represents either one or two project locations each of which incorporates several test sections. Each row represents a series of test sections with specific features to be constructed at each project location. The ADOT project falls in the Dry-No Freeze JPCP category.

TEST SECTION LAYOUT AND FEATURES

Originally eight SHRP test sections and five ADOT test sections were designed as part of ADOT construction project IR-40-4(123). These test sections are located on the eastbound travel lane of I-40 near Flagstaff beginning at milepost 202.16 and extending through milepost 204.20 (2.04 miles). ADOT added six more sections during the construction phase, which were not in the original design. These sections extend

Table 1. Experimental design for SPS-6, rehabilitation of jointed portland cement concrete pavements.

Rehabilitation Procedures \ Factors for Moisture, Temperature, Pavement Type, and Pavement Condition		WET FREEZE				WET, NO FREEZE				DRY FREEZE				DRY, NO FREEZE	
		JPCP		JRCP		JPCP		JRCP		JPCP		JRCP		JPCP	
		FAIR	POOR	FAIR	POOR	FAIR	POOR	FAIR	POOR	FAIR	POOR	FAIR	POOR	FAIR	POOR
PREPARATION	OVERLAY THICKNESS														
Routine Maintenance (Control)	0	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	x	x	x	x
Minimum Restoration	0	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	x	x	x	x
	4"	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	x	x	x	x
	4" •	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	x	x	x	x
Maximum Restoration (CPR)	0	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	x	x	x	x
	4"	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	x	x	x	x
Crack/Break and Seat	4"	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	x	x	x	x
	8"	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	x	x	x	x

• with saw AC overlay joints above JCP joints and seal

Subgrade Soil: Fine
Traffic: >200 KESAL/Year

Each "x" designates a test section.

from MP 204.21 to MP 204.84 (.57 miles). The construction was a part of rehabilitation of the existing I-40 PCC pavement from milepost 195.08 to milepost 205.20.

Test section identification and features are listed in Table 2. The layout of the test sections with transitions is in Figure 1.

SHRP 040601 is the control section or part of the existing pavement left as it was. This section is to receive only routine maintenance. Each test section has a SHRP test section sign along with the experimental feature at the beginning of the test section on the shoulder and also by the fence on the right-of-way. Also, SHRP test section numbers were painted on the shoulder for each test section. Delimiters with blue reflectors were also used to delineate the beginning and end of the test sections.

TABLE 2. SPS-6 TEST SECTION FEATURES

SHRP ID	ADOT No.	Location From	Location To	Length ft.	Surface Preparation	Overlay Material	Overlay Thickness, inches
ADOT 040609	1*	0+00	4+94	494	Rubblize	AC	8
ADOT 040613	2*	6+63	11+62	499	Crack and Seat	PCC/AC	10/2
SHRP 040608	3	14+42	19+38	496	Crack and Seat	AC	8
SHRP 040607	4	22+18	27+14	496	Crack and Seat	AC	4
SHRP 040606	5	29+74	34+69	495	Maximum	AC	4
ADOT 040610	6*	37+70	43+67	597	Fabric/Crack and Seat	AC	4
ADOT 040611	7*	45+38	49+75	437	Crack and Seat	ARAC/AC	2/2
SHRP 040604	8	51+24	56+21	497	Saw and Seal/Minimum	AC	4
ADOT 040612	9*	61+40	66+64	524	Crack and Seat	AC/ARAC	2/2
SHRP 040603	10	72+96	78+02	506	Minimum	AC	4
SHRP 040605	11	80+15	90+09	994	Maximum	None	None
SHRP 040602	12	95+92	101+63	571	Minimum	None	None
SHRP 040601	13	103+47	108+48	501	Routine Maintenance	None	None (Control)
ADOT 040614	14*	112+02	117+02	500	None	AR-ACFC ARAC/AC	0.50 2/3
ADOT 040615	15*	117+02	123+24	622	Crack and Seat	AR-ACFC ARAC/AC	0.50 2/3
ADOT 040616	16*	123+24	128+24	500	Rubblize	AR-ACFC ARAC/AC	0.50 2/3
ADOT 040617	17*	128+24	133+24	500	Crack and Seat	AR-ACFC ARAC/AC	0.50 2/3
ADOT 040618	18*	133+24	137+24	400	None	AR-ACFC ARAC/AC	0.50 2/3
ADOT 040619	19*	137+24	142+24	500	Rubblize	AR-ACFC ARAC/AC	0.50 2/3

NOTE: Approximately one month after construction of Sections 1 - 13, a 5/8" thick ACFC was placed on Sections 3, 4, 5, 6, 7, 9, 10 to reduce concern about potential raveling and skid characteristics of AC surface.

* - ADOT Experimental Test Section
ARAC - Asphalt Rubber Asphalt Concrete
ACFC - Asphalt Concrete Friction Course
AR-ACFC - Asphalt Rubber Asphalt Concrete Friction Course

ARIZONA SPS-6
TEST SECTION FEATURES AND LENGTHS

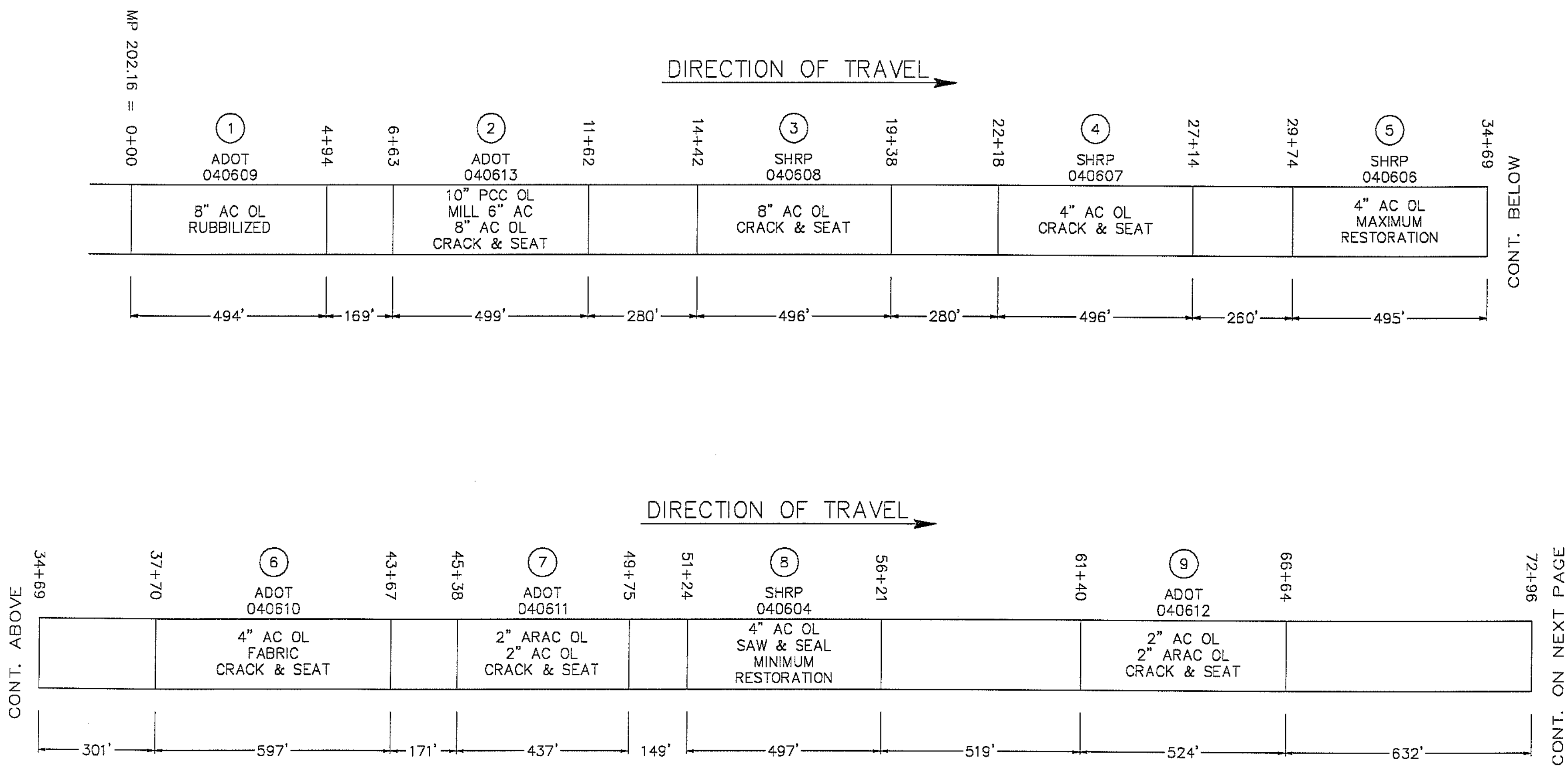


Figure 1. LAYOUT OF TEST SECTIONS

ARIZONA SPS-6
TEST SECTION FEATURES AND LENGTHS

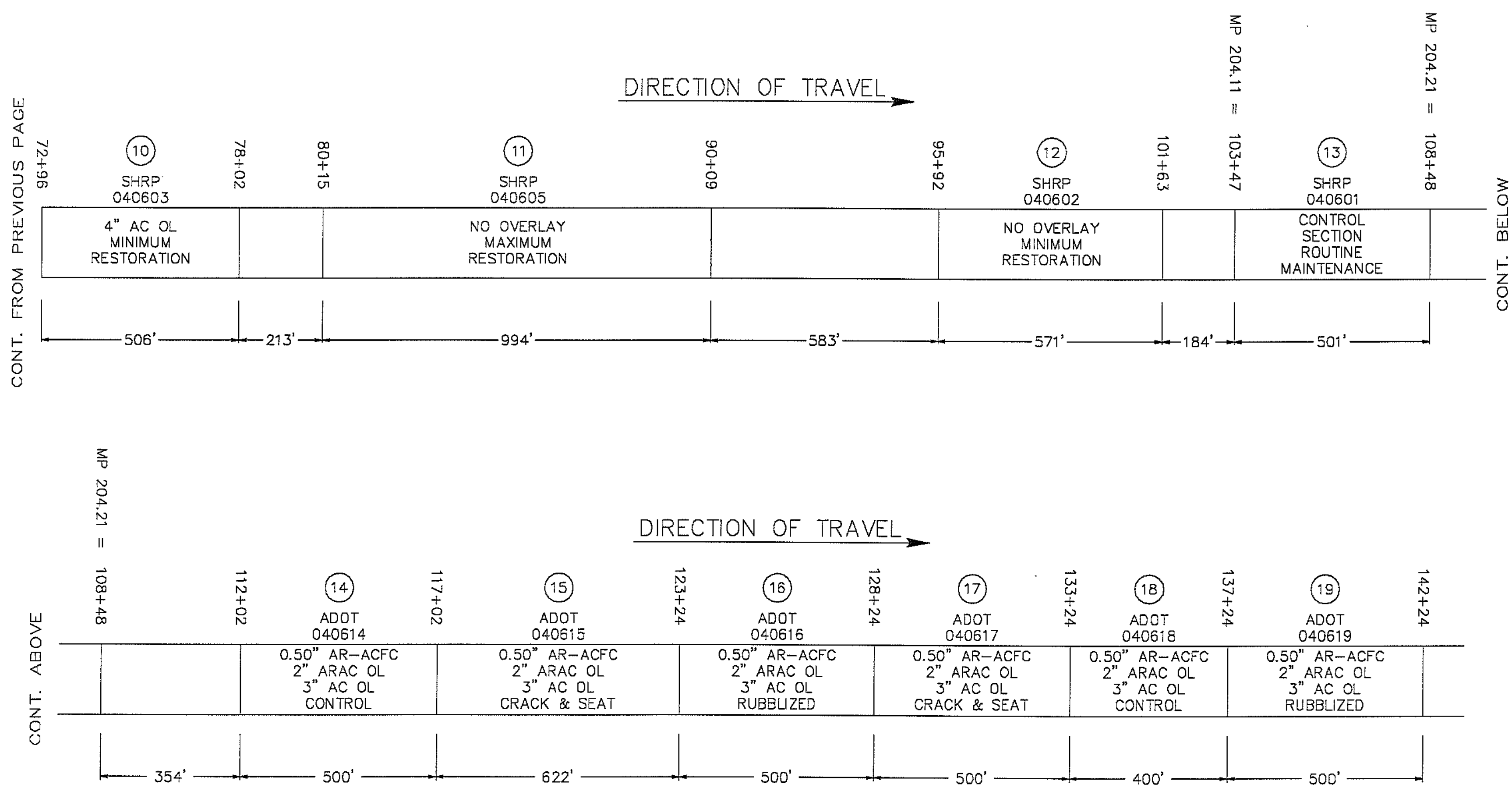


Figure 1. (continued)

III. EXISTING PROJECT DESCRIPTION

LOCATION

The project is located at Flagstaff in Central Arizona (Coconino County) extending from U.S. 89A (milepost 195) to the Walnut Canyon Interchange (milepost 205) in the eastbound direction of I-40. Total project length is 10 miles. It is located in ADOT District 4. Average project elevation is 6900'.

PAVEMENT SECTION

The existing project is a 38' roadway, consisting of two 12' wide travel lanes, a 10' outside shoulder, and 4' inside shoulder. The travel lanes are PCCP, 8" to 9" thick, and the shoulders are 2.5" to 3" of AC. Figure 2 shows the structural section of the existing pavement.

CLIMATE

The minimum and maximum daily temperatures during the period of test section construction, June through October of 1990, are shown graphically in Figure 3. The daily precipitation is graphed in Figure 4. A list of the temperatures and precipitation are in Table 2.

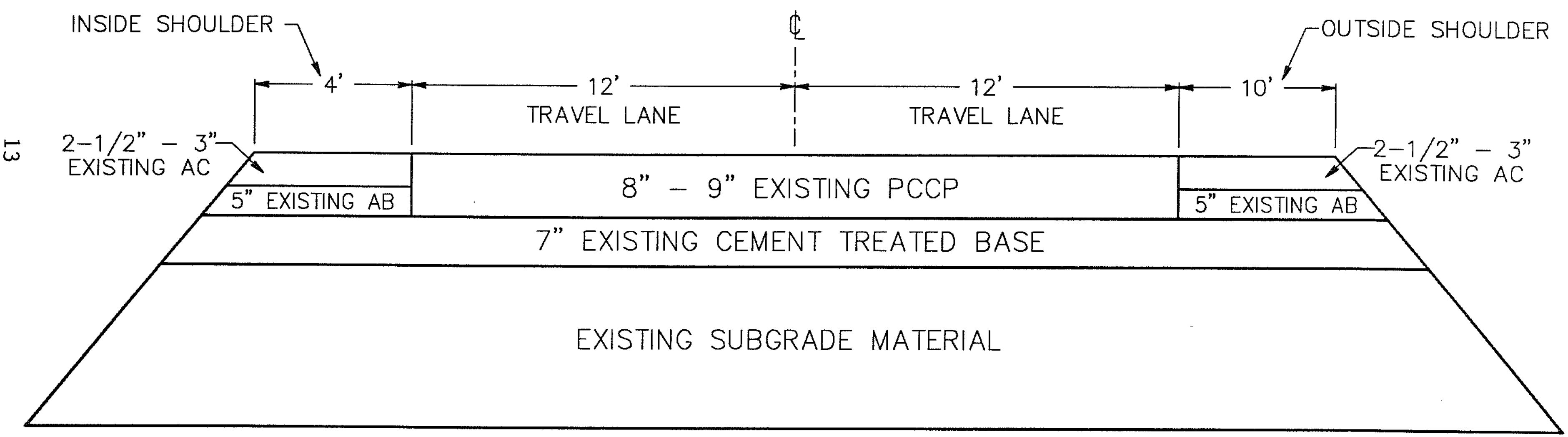


FIGURE 2. EXISTING PAVEMENT SECTION

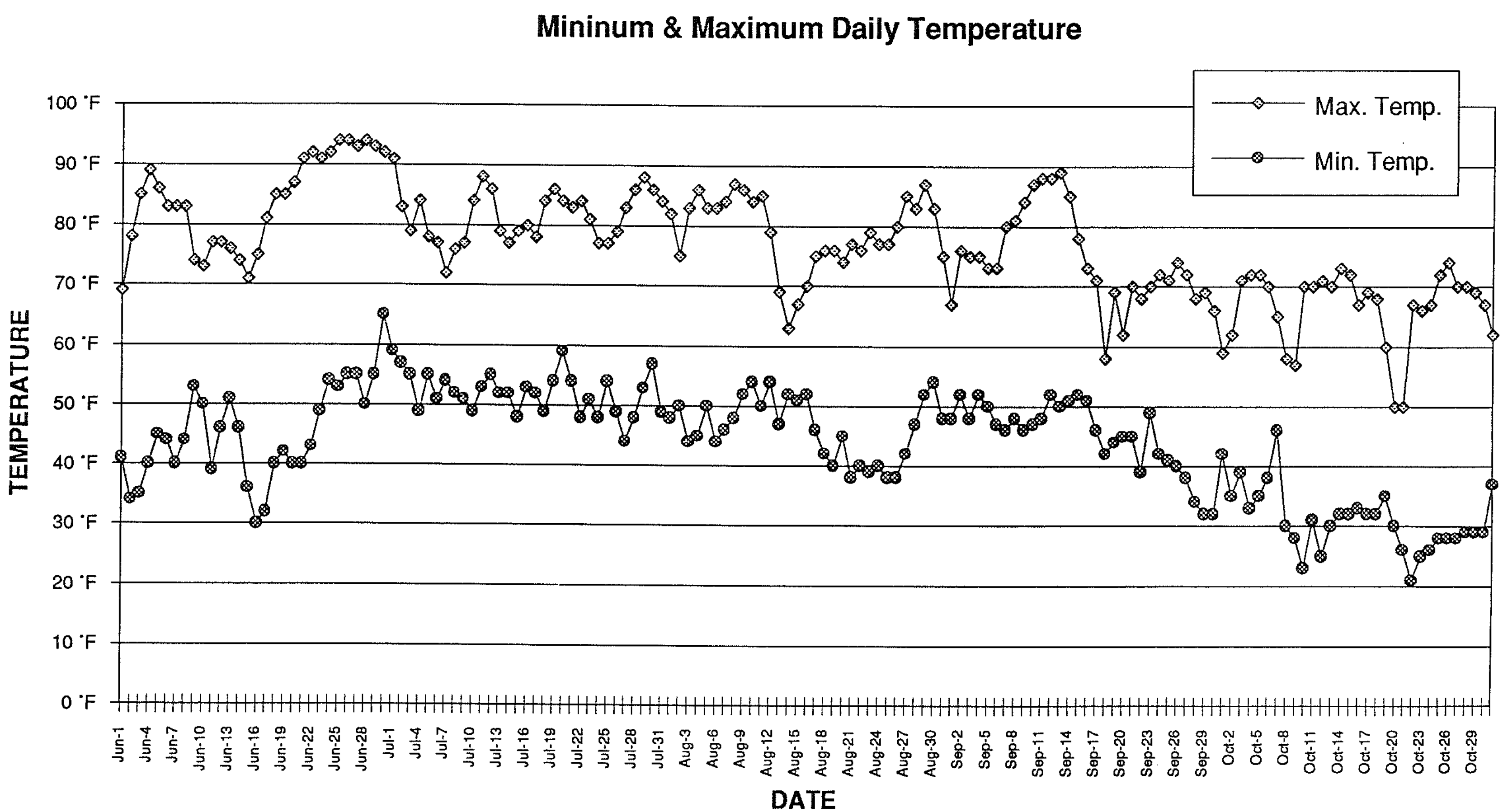


FIGURE 3. TEMPERATURES DURING CONSTRUCTION PERIOD

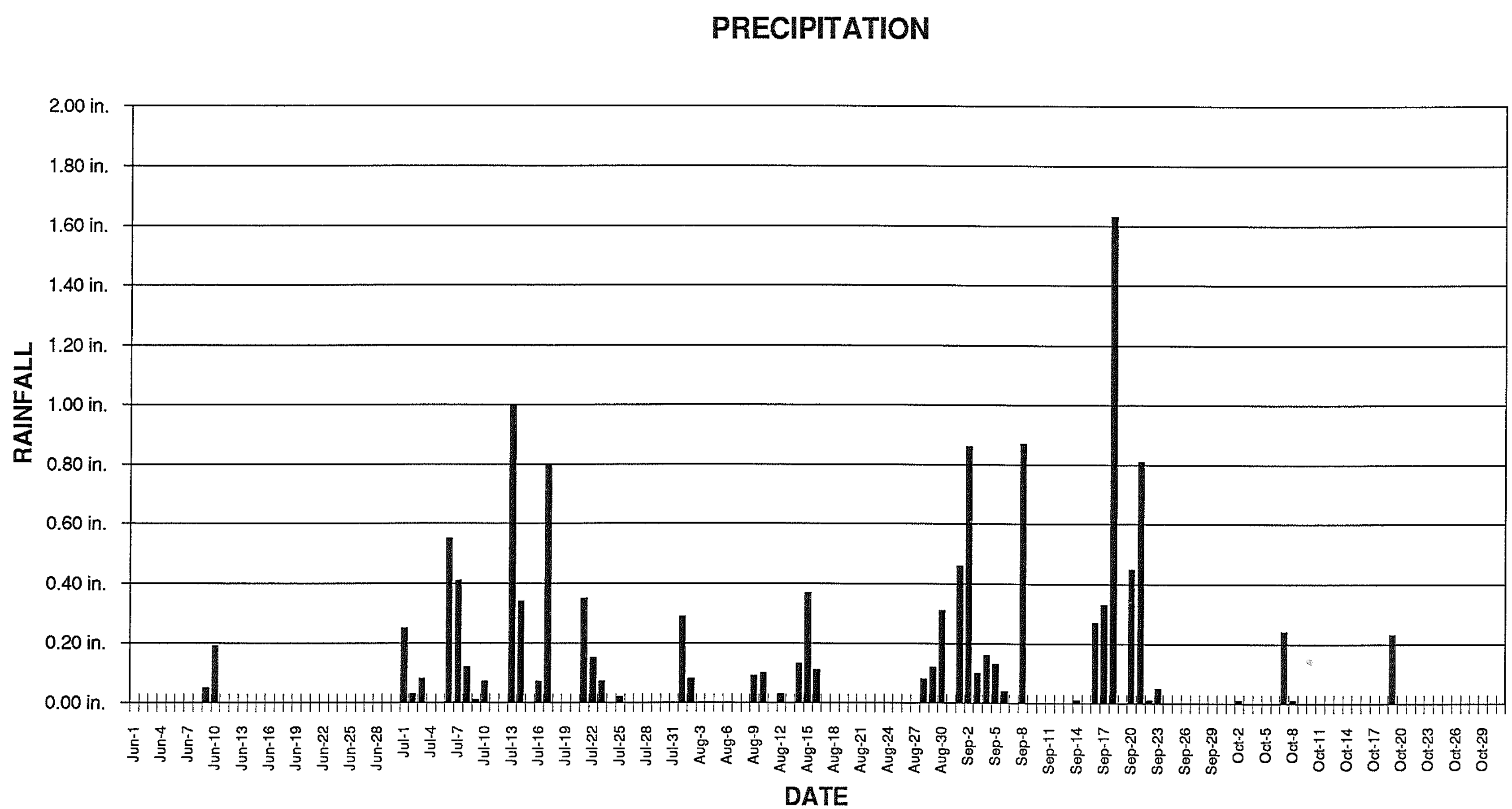


FIGURE 4. PRECIPITATION DURING CONSTRUCTION PERIOD

TABLE 2 a

LOCAL CLIMATOLOGICAL DATA

Source: NOAA Weather Station Pulliam Airport Flagstaff, AZ

Date	*Max. Temp.*	*Min. Temp.*	*Precipitation*
Jun-1	69 °F	41 °F	0.00 in.
Jun-2	78 °F	34 °F	0.00 in.
Jun-3	85 °F	35 °F	0.00 in.
Jun-4	89 °F	40 °F	0.00 in.
Jun-5	86 °F	45 °F	0.00 in.
Jun-6	83 °F	44 °F	0.00 in.
Jun-7	83 °F	40 °F	0.00 in.
Jun-8	83 °F	44 °F	0.00 in.
Jun-9	74 °F	53 °F	0.05 in.
Jun-10	73 °F	50 °F	0.19 in.
Jun-11	77 °F	39 °F	0.00 in.
Jun-12	77 °F	46 °F	0.00 in.
Jun-13	76 °F	51 °F	0.00 in.
Jun-14	74 °F	46 °F	0.00 in.
Jun-15	71 °F	36 °F	0.00 in.
Jun-16	75 °F	30 °F	0.00 in.
Jun-17	81 °F	32 °F	0.00 in.
Jun-18	85 °F	40 °F	0.00 in.
Jun-19	85 °F	42 °F	0.00 in.
Jun-20	87 °F	40 °F	0.00 in.
Jun-21	91 °F	40 °F	0.00 in.
Jun-22	92 °F	43 °F	0.00 in.
Jun-23	91 °F	49 °F	0.00 in.
Jun-24	92 °F	54 °F	0.00 in.
Jun-25	94 °F	53 °F	0.00 in.
Jun-26	94 °F	55 °F	0.00 in.
Jun-27	93 °F	55 °F	0.00 in.
Jun-28	94 °F	50 °F	0.00 in.
Jun-29	93 °F	55 °F	0.00 in.
Jun-30	92 °F	65 °F	0.00 in.
Jul-1	91 °F	59 °F	0.25 in.
Jul-2	83 °F	57 °F	0.03 in.
Jul-3	79 °F	55 °F	0.08 in.
Jul-4	84 °F	49 °F	0.00 in.
Jul-5	78 °F	55 °F	0.00 in.
Jul-6	77 °F	51 °F	0.55 in.
Jul-7	72 °F	54 °F	0.41 in.
Jul-8	76 °F	52 °F	0.12 in.
Jul-9	77 °F	51 °F	0.01 in.
Jul-10	84 °F	49 °F	0.07 in.
Jul-11	88 °F	53 °F	0.00 in.
Jul-12	86 °F	55 °F	0.00 in.
Jul-13	79 °F	52 °F	1.00 in.
Jul-14	77 °F	52 °F	0.34 in.
Jul-15	79 °F	48 °F	0.00 in.
Jul-16	80 °F	53 °F	0.07 in.
Jul-17	78 °F	52 °F	0.80 in.
Jul-18	84 °F	49 °F	0.00 in.
Jul-19	86 °F	54 °F	0.00 in.
Jul-20	84 °F	59 °F	0.00 in.
Jul-21	83 °F	54 °F	0.35 in.
Jul-22	84 °F	48 °F	0.15 in.
Jul-23	81 °F	51 °F	0.07 in.
Jul-24	77 °F	48 °F	0.00 in.
Jul-25	77 °F	54 °F	0.02 in.
Jul-26	79 °F	49 °F	0.00 in.
Jul-27	83 °F	44 °F	0.00 in.
Jul-28	86 °F	48 °F	0.00 in.
Jul-29	88 °F	53 °F	0.00 in.
Jul-30	86 °F	57 °F	0.00 in.
Jul-31	84 °F	49 °F	0.00 in.

TABLE 2 a (continued)

LOCAL CLIMATOLOGICAL DATA

Source: NOAA Weather Station Pulliam Airport Flagstaff, AZ

Date	Max. Temp.	Min. Temp.	Precipitation
Aug-1	82 °F	48 °F	0.29 in.
Aug-2	75 °F	50 °F	0.08 in.
Aug-3	83 °F	44 °F	0.00 in.
Aug-4	86 °F	45 °F	0.00 in.
Aug-5	83 °F	50 °F	0.00 in.
Aug-6	83 °F	44 °F	0.00 in.
Aug-7	84 °F	46 °F	0.00 in.
Aug-8	87 °F	48 °F	0.00 in.
Aug-9	86 °F	52 °F	0.09 in.
Aug-10	84 °F	54 °F	0.10 in.
Aug-11	85 °F	50 °F	0.00 in.
Aug-12	79 °F	54 °F	0.03 in.
Aug-13	69 °F	47 °F	0.00 in.
Aug-14	63 °F	52 °F	0.13 in.
Aug-15	67 °F	51 °F	0.37 in.
Aug-16	70 °F	52 °F	0.11 in.
Aug-17	75 °F	46 °F	0.00 in.
Aug-18	76 °F	42 °F	0.00 in.
Aug-19	76 °F	40 °F	0.00 in.
Aug-20	74 °F	45 °F	0.00 in.
Aug-21	77 °F	38 °F	0.00 in.
Aug-22	76 °F	40 °F	0.00 in.
Aug-23	79 °F	39 °F	0.00 in.
Aug-24	77 °F	40 °F	0.00 in.
Aug-25	77 °F	38 °F	0.00 in.
Aug-26	80 °F	38 °F	0.00 in.
Aug-27	85 °F	42 °F	0.00 in.
Aug-28	83 °F	47 °F	0.08 in.
Aug-29	87 °F	52 °F	0.12 in.
Aug-30	83 °F	54 °F	0.31 in.
Aug-31	75 °F	48 °F	0.00 in.
Sep-1	67 °F	48 °F	0.46 in.
Sep-2	76 °F	52 °F	0.86 in.
Sep-3	75 °F	48 °F	0.10 in.
Sep-4	75 °F	52 °F	0.16 in.
Sep-5	73 °F	50 °F	0.13 in.
Sep-6	73 °F	47 °F	0.04 in.
Sep-7	80 °F	46 °F	0.00 in.
Sep-8	81 °F	48 °F	0.87 in.
Sep-9	84 °F	46 °F	0.00 in.
Sep-10	87 °F	47 °F	0.00 in.
Sep-11	88 °F	48 °F	0.00 in.
Sep-12	88 °F	52 °F	0.00 in.
Sep-13	89 °F	50 °F	0.00 in.
Sep-14	85 °F	51 °F	0.01 in.
Sep-15	78 °F	52 °F	0.00 in.
Sep-16	73 °F	51 °F	0.27 in.
Sep-17	71 °F	46 °F	0.33 in.
Sep-18	58 °F	42 °F	1.63 in.
Sep-19	69 °F	44 °F	0.00 in.
Sep-20	62 °F	45 °F	0.45 in.
Sep-21	70 °F	45 °F	0.81 in.
Sep-22	68 °F	39 °F	0.01 in.
Sep-23	70 °F	49 °F	0.05 in.
Sep-24	72 °F	42 °F	0.00 in.
Sep-25	71 °F	41 °F	0.00 in.
Sep-26	74 °F	40 °F	0.00 in.
Sep-27	72 °F	38 °F	0.00 in.
Sep-28	68 °F	34 °F	0.00 in.
Sep-29	69 °F	32 °F	0.00 in.
Sep-30	66 °F	32 °F	0.00 in.

TABLE 2a (continued)

LOCAL CLIMATOLOGICAL DATA

Source: NOAA Weather Station Pulliam Airport Flagstaff, AZ

Date	*Max. Temp.*	*Min. Temp.*	*Precipitation*
Oct-1	59 °F	42 °F	0.00 in.
Oct-2	62 °F	35 °F	0.01 in.
Oct-3	71 °F	39 °F	0.00 in.
Oct-4	72 °F	33 °F	0.00 in.
Oct-5	72 °F	35 °F	0.00 in.
Oct-6	70 °F	38 °F	0.00 in.
Oct-7	65 °F	46 °F	0.24 in.
Oct-8	58 °F	30 °F	0.01 in.
Oct-9	57 °F	28 °F	0.00 in.
Oct-10	70 °F	23 °F	0.00 in.
Oct-11	70 °F	31 °F	0.00 in.
Oct-12	71 °F	25 °F	0.00 in.
Oct-13	70 °F	30 °F	0.00 in.
Oct-14	73 °F	32 °F	0.00 in.
Oct-15	72 °F	32 °F	0.00 in.
Oct-16	67 °F	33 °F	0.00 in.
Oct-17	69 °F	32 °F	0.00 in.
Oct-18	68 °F	32 °F	0.00 in.
Oct-19	60 °F	35 °F	0.23 in.
Oct-20	50 °F	30 °F	0.00 in.
Oct-21	50 °F	26 °F	0.00 in.
Oct-22	67 °F	21 °F	0.00 in.
Oct-23	66 °F	25 °F	0.00 in.
Oct-24	67 °F	26 °F	0.00 in.
Oct-25	72 °F	28 °F	0.00 in.
Oct-26	74 °F	28 °F	0.00 in.
Oct-27	70 °F	28 °F	0.00 in.
Oct-28	70 °F	29 °F	0.00 in.
Oct-29	69 °F	29 °F	0.00 in.
Oct-30	67 °F	29 °F	0.00 in.
Oct-31	62 °F	37 °F	0.00 in.

IV. EXISTING PAVEMENT PERFORMANCE

TRAFFIC

Design data shown on the project rehabilitation plan drawings indicates 1990 ADT is 8000 and projected 2000 ADT is 12000. This a projected growth of 4.2% annually. Results of actual traffic measurements from the High Speed Weigh-in-Motion equipment installed in Test Section 2 are shown in Figure 5 (Ref. 4). This data was collected in January through July of 1991, a few months after construction of the test sections. ADT on eastbound I-40 in this period ranged from 4206 in January to 7816 in June. Figure 6 shows the truck average speed which is between 60 and 65 mph.

FUNCTIONAL PERFORMANCE

The functional performance of the roadway can best be described by its serviceability. Arizona performs an annual inventory of its highway network and records this information on a route-milepost basis. Roughness, skid, patching, and faulting are measured in the travel lane and entered into the pavement management system database.

Roughness is determined by a Mays Ride Meter (car) traveling at 50 mph which obtains continuous readings between mileposts. The readings are summarized in inches per mile and the results assigned to the milepost location at which the readings begin. Once the field data is obtained it is normalized to 1972 calibration values to provide consistency with time.

Skid (friction) is determined by a Mu-Meter which is a continuous recording friction measuring trailer. Continuous readings are obtained for a five hundred foot section of wet pavement starting at a milepost location. The readings are averaged and assigned to the milepost.

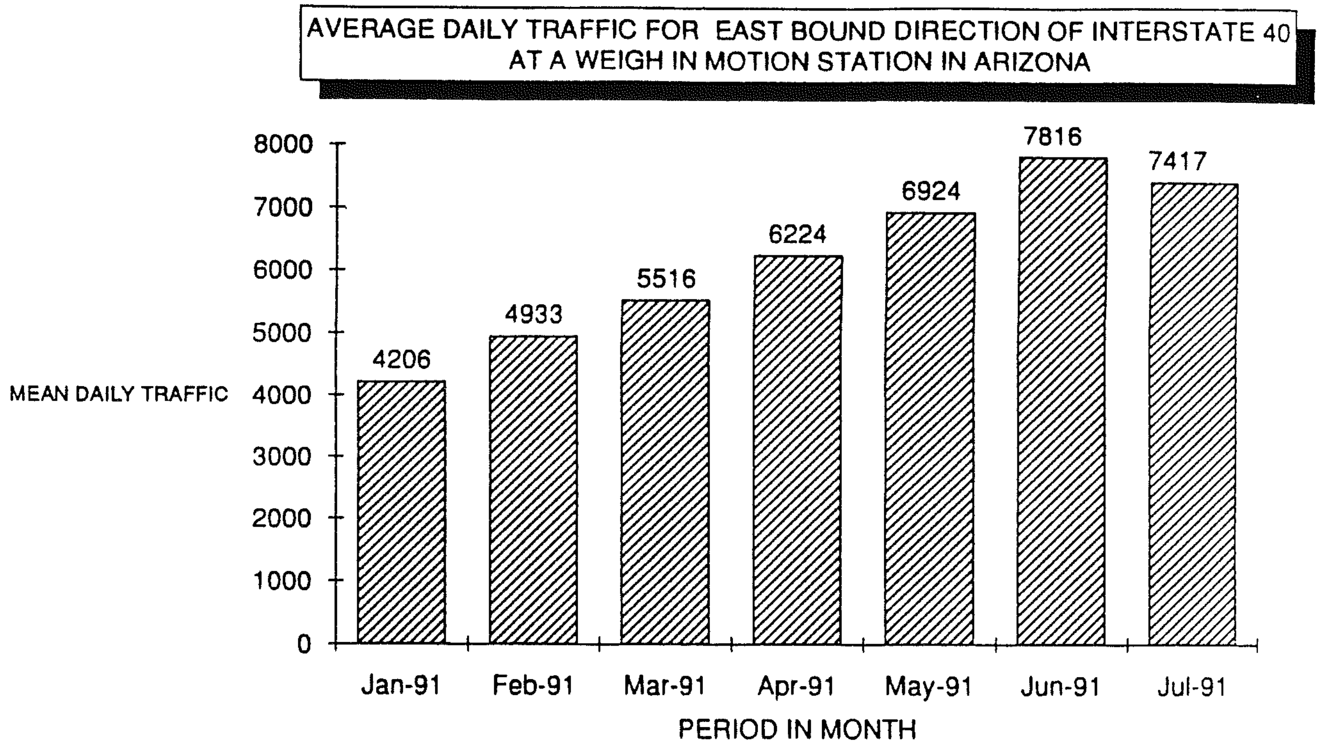


FIGURE 5. ADT ON TEST SECTIONS

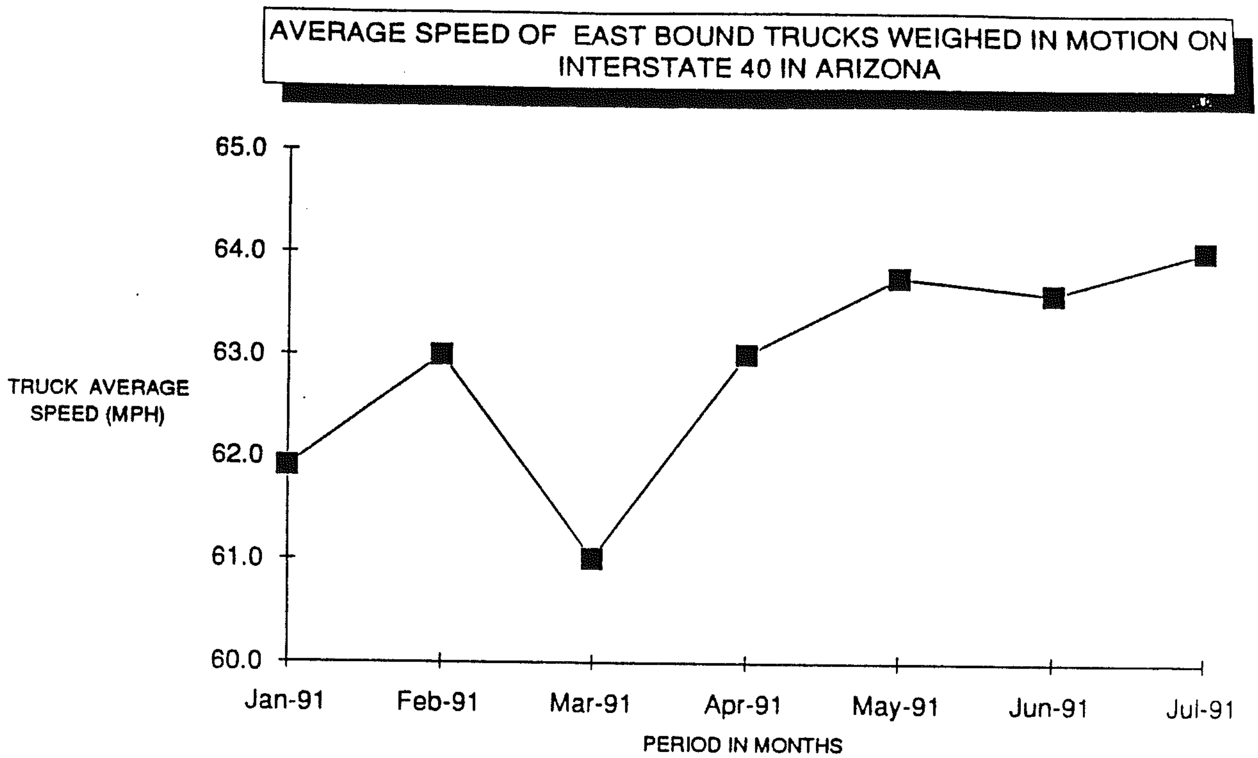


FIGURE 6. AVERAGE TRUCK SPEED ON TEST SECTIONS

Serviceability data prior to construction of the test sections was not made available for inclusion in this report. The ADOT PMS data base may be consulted for this information, if desired.

STRUCTURAL PAVEMENT PERFORMANCE

The structural condition of pavements are typically evaluated by ADOT in the form of pavement distress surveys, Dynaflect and Falling Weight Deflectometer tests. Historical structural data is available in ADOT's PMS database. Results of pavement distress surveys conducted prior to construction of the test sections are discussed in Section VI of this report.

MATERIAL RELATED PROBLEMS

Since ADOT's PMS does not report any material related distress, no records are available on the development of this distress. However, pre-construction inspection of this project did not reveal any problems.

V. CONSTRUCTION PROJECT DESCRIPTION

SECTION DESIGNS AND SPECIFICATIONS

All the SHRP test sections were designed following the ideas in the SHRP "Specific Pavement Studies Experimental Design and Research Plan for Experiment SPS-6 Rehabilitation of Jointed Portland Cement Concrete Pavements". A copy is included in Appendix A. The designs were included in ADOT construction project IR-40-4(123). Figure 7 shows the typical construction sections and Figure 8 shows the pavement structural sections for each test section. Test section numbers have been added to these construction plan sheets for ready reference. Figure 9 shows the test section layout sequence and Figure 10 shows the typical vertical taper treatment. It should be noted that actual constructed test section lengths differed somewhat from the lengths on these plan sheets. A brief description of design features is as follows:

Test Section 1 (ADOT 040609): Rubblize the existing 8" to 9" PCCP according to project special provisions. The intent is to break-up the pavement into nominal 1" to 2" pieces. Compact with a vibratory roller and place prime coat prior to overlay. Overlay with asphaltic concrete (virgin AC 3/4) in 3 lifts - 3", 3", and 2" for final lift - for a total overlay thickness of 8". Place a tack coat between lifts.

Test Section 2 (ADOT 040613): Crack and seat the existing PCCP according to project special provisions. The nominal crack spacing should be 3' x 3'. The pavement should then be rolled until the broken pieces are seated. Place tack coat on top of PCCP. Place 8" thick AC overlay according to specifications. Place tack coat between lifts. Mill off 6" of the 8" overlay, leaving 2" in-place as an AC bondbreaker. Construct a new unbonded 10" PCCP overlay with dowels and tie bars as noted in plans.

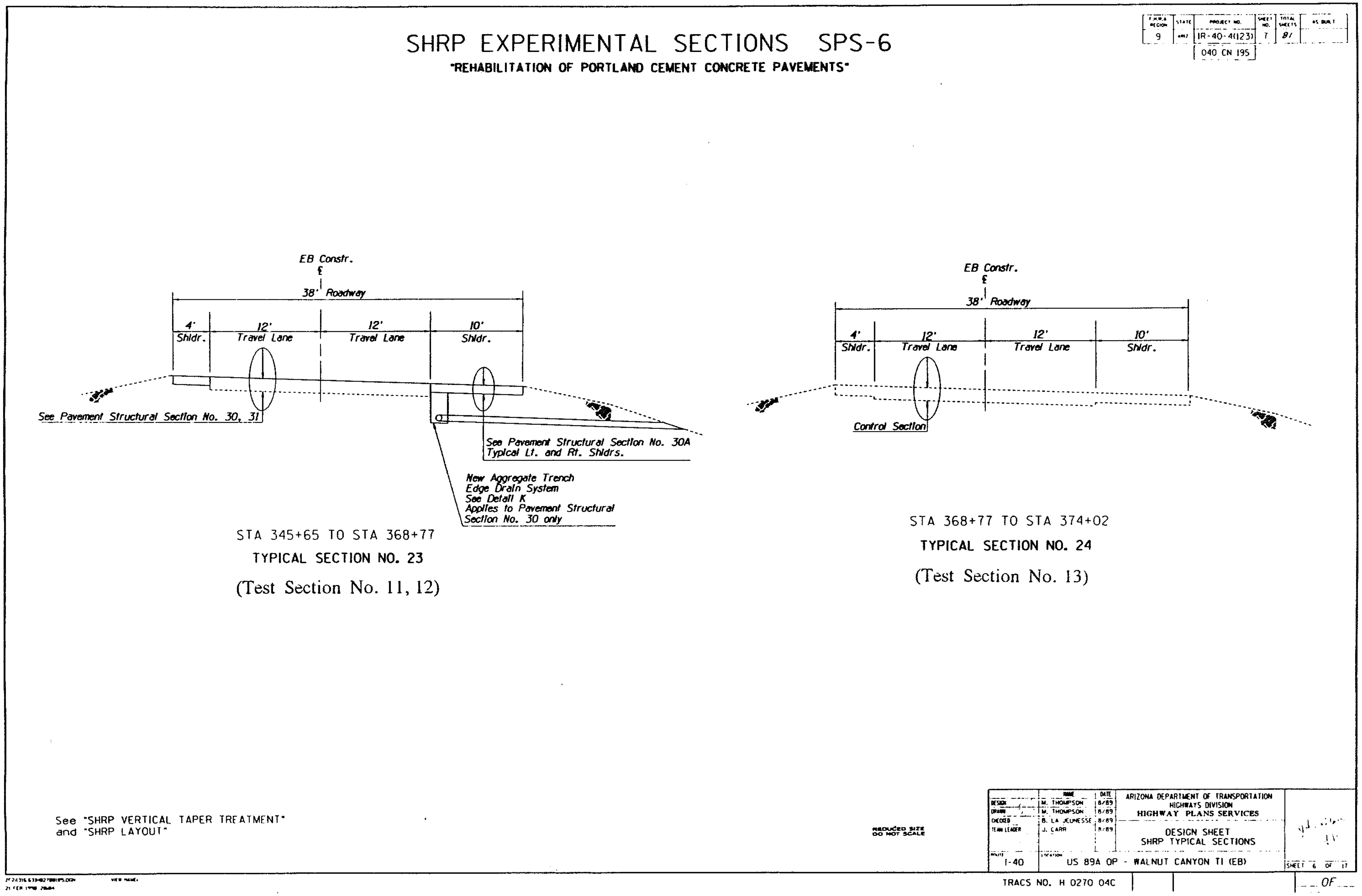


FIGURE 7. TYPICAL CONSTRUCTION SECTIONS

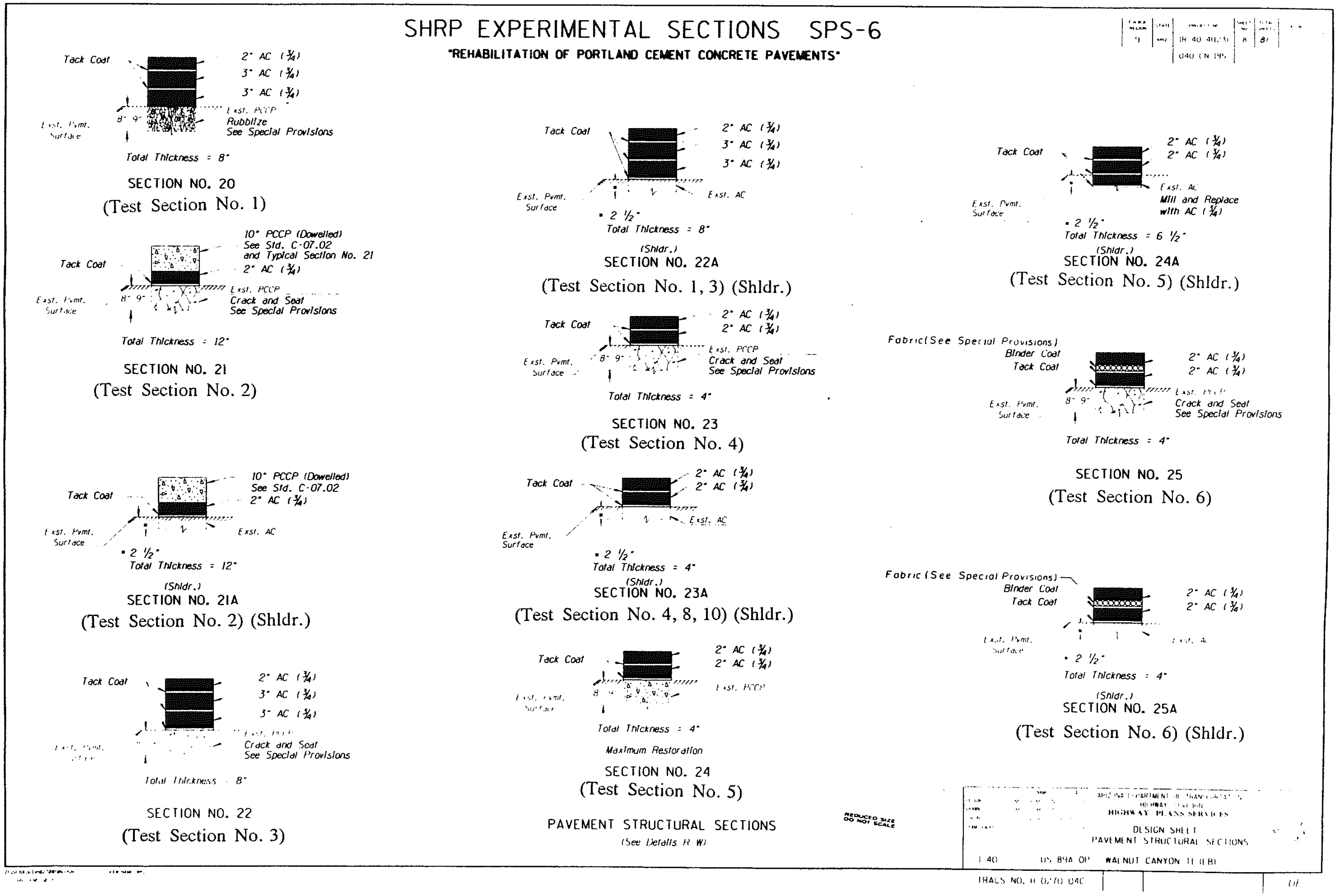


FIGURE 8. PAVEMENT STRUCTURAL SECTIONS

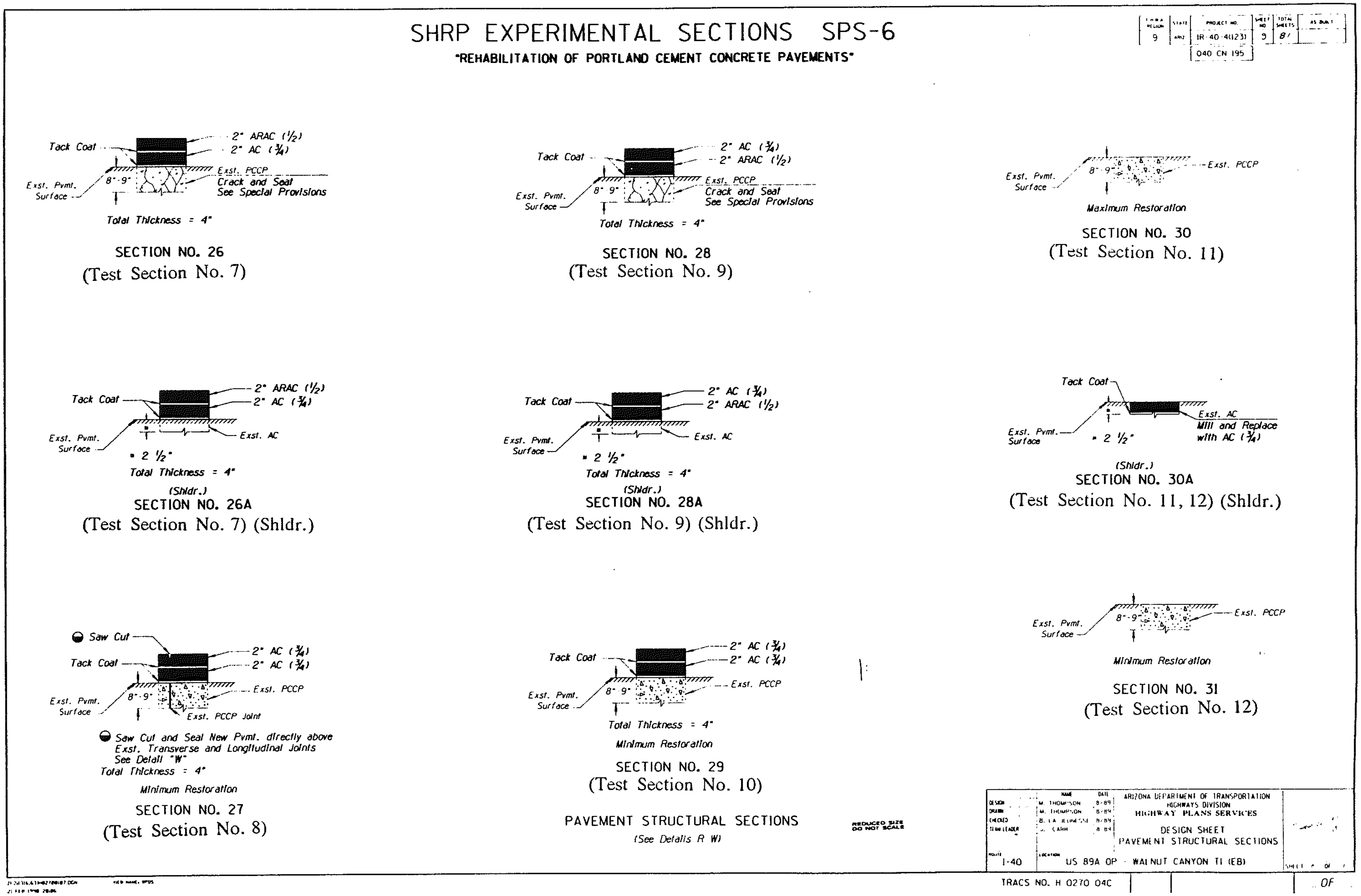


FIGURE 8. PAVEMENT STRUCTURAL SECTIONS (continued)

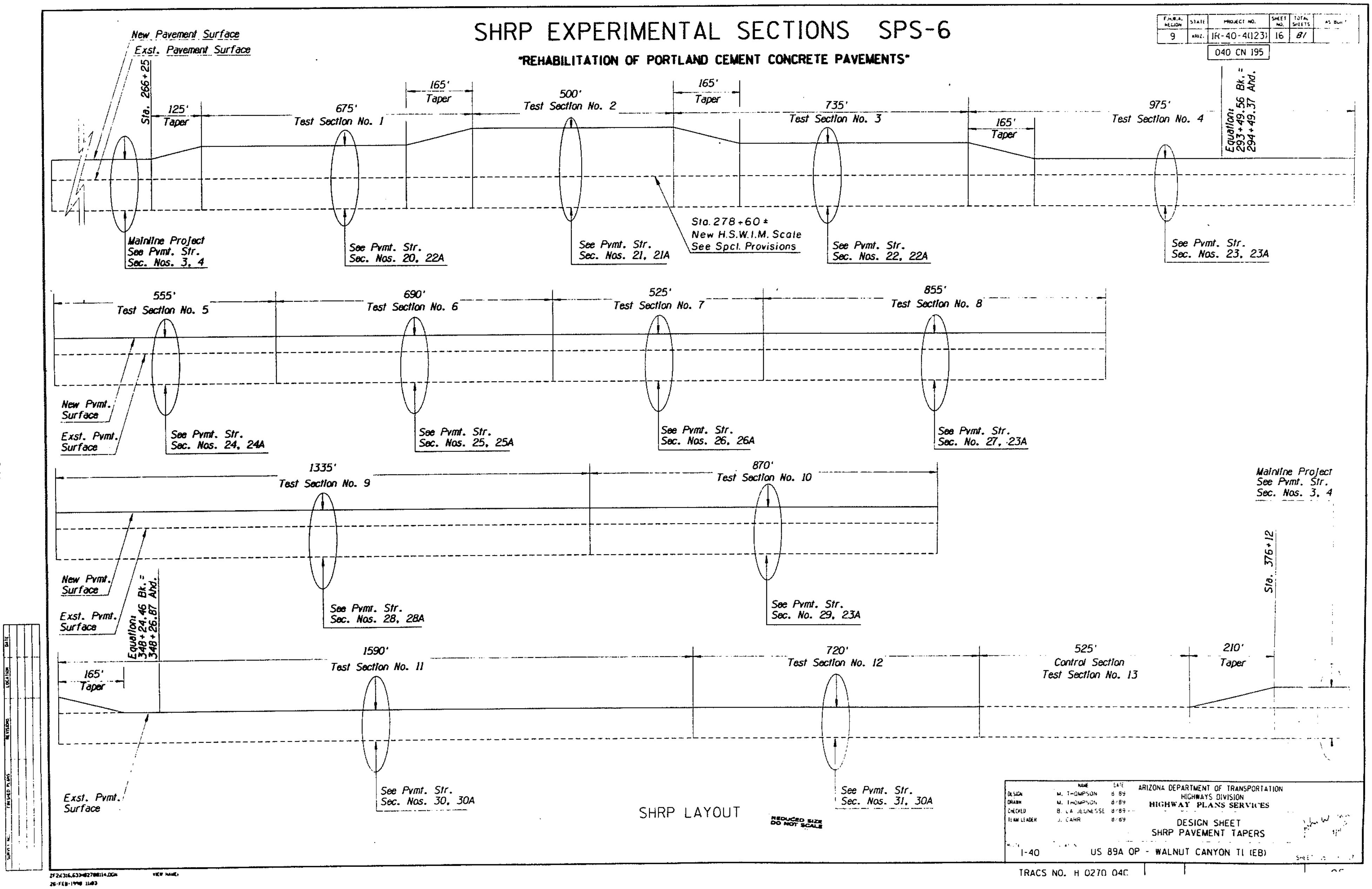


FIGURE 9. TEST SECTION LAYOUT SEQUENCE

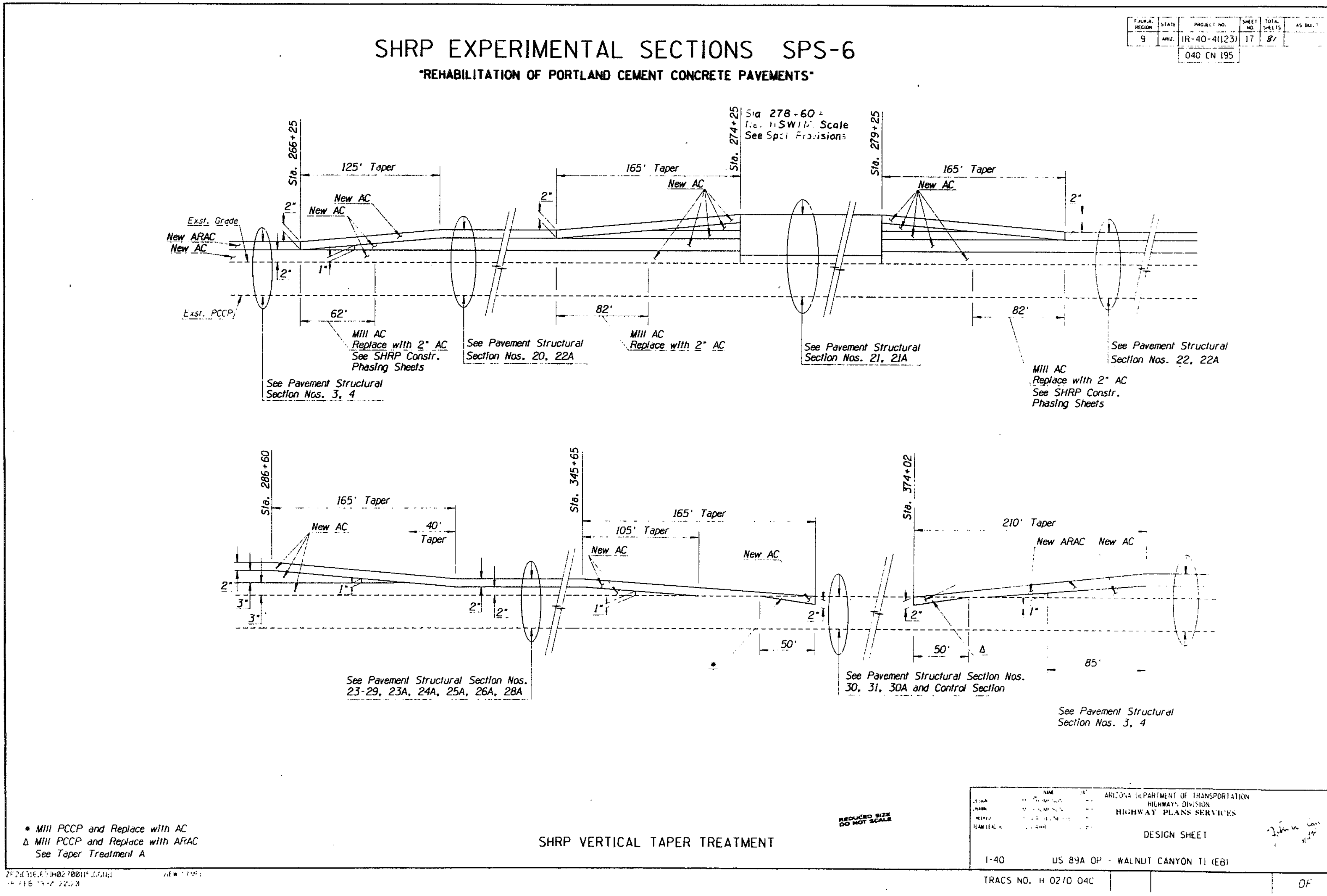


FIGURE 10. TYPICAL VERTICAL TAPER TREATMENT

Test Section 3 (SHRP 040608): Crack and seat the existing PCCP according to project special provisions. Apply a tack coat. Overlay with virgin AC (3/4) in 3 lifts - 3", 3", and 2" for total thickness of 8". Place tack coat between lifts. (Note: Approximately one month after construction a 5/8" ACFC was added to this section).

Test Section 4 (SHRP 040607): Crack and seat existing PCCP according to project special provisions. Apply tack coat. Overlay with AC (3/4) in two lifts - 2" and 2" - for total overlay thickness of 4". Place a tack coat between lifts. (Note: Approximately one month after construction a 5/8" ACFC was added to this section).

Test Section 5 (SHRP 040606): Prepare existing PCCP surface using maximum restoration procedures according to project special provisions and plans. Maximum restoration includes removing existing AC patches, full-depth removal and replacement of existing slabs (including dowels and tie bars), partial depth spall repair, and milling and replacing existing AC shoulders. Do not grind surface. After restoration place an AC (3/4) overlay in two lifts - 2" and 2" - for total overlay thickness of 4". Place a tack coat between lifts and on PCCP prior to overlay. (Note: Approximately one month after construction a 5/8" ACFC was added to this section).

Test Section 6 (ADOT 040610): Crack and seat existing PCCP according to special provisions. Apply tack coat. Place 2" lift of AC (3/4). Place binder coat and paving fabric. Place final 2" lift of AC (3/4), for total overlay thickness of 4". (Note: Approximately one month after construction a 5/8" ACFC was added to this section).

Test Section 7 (ADOT 040611): Crack and seat existing PCCP according to special provisions. Apply tack coat. Place 2" lift of AC (3/4) and 2" lift of asphalt rubber AC - ARAC (1/2), for a total overlay thickness of 4". Place tack coat between lifts. (Note: Approximately one month after construction a 5/8" ACFC was added to this section).

Test Section 8 (SHRP 040604): Prepare existing PCCP surface using minimum restoration procedures in project special provisions. Minimum restoration includes partial depth spall repair and partial and full-depth patching, if warranted. No joint or crack sealing should be done. Apply tack coat. Place AC (3/4) overlay in two 2" lifts, for total overlay thickness of 4". Place a tack coat between lifts. Saw and seal AC overlay to match underlying joints and working cracks in PCCP.

Test Section 9 (ADOT 040612): Crack and seat existing PCCP according to special provisions. Place tack coat and a 2" lift of ARAC (1/2). Place tack coat and 2" lift of AC (3/4), for total overlay thickness of 4". (Note: Approximately one month after construction a 5/8" ACFC was added to this section).

Test Section 10 (SHRP 040603): Prepare existing PCCP surface using minimum restoration procedures including spall repair and partial and full-depth patching, if warranted. Place AC (3/4)overlay in two lifts of 2" each, for a total overlay of 4". Place tack coat between lifts and on top of PCCP. (Note: Approximately one month after construction a 5/8" ACFC was added to this section).

Test Section 11 (SHRP 040605): Prepare existing surface with maximum restoration procedures which may include removing existing AC patches, removing and replacing slabs including tie bars and dowels, saw and seal new and existing joints, saw and seal cracks, saw and seal longitudinal joint at shoulder, perform partial depth spall repair, and grind full roadway surface for smoothness. No overlay is to be placed.

Test Section 12 (SHRP 040602): Prepare existing surface with minimum restoration, including partial depth spall repairs, joint and crack sealing touch-up, mill and replace existing shoulder, and seal joint between shoulder and existing PCCP. No overlay is to be placed.

Test Section 13 (SHRP 040601): This is the control section which receives no special surface preparation or overlay. It is to receive routine maintenance as typically performed by ADOT. Three to five years of service is desired out of this section.

Test Section 14 (ADOT 040614): Perform no preparation on existing surface. Apply tack coat. Place 3" AC (3/4), 2" ARAC, .50" AR-ACFC. Tack coat between lifts.

Test Section 15 (ADOT 040615): Crack and seat existing PCC (4' x 6'). Apply tack coat. Place 3" AC (3/4), 2" ARAC, .50" AR-ACFC. Tack coat between lifts.

Test Section 16 (ADOT 040616): Rubblize existing PCC surface. Apply tack coat. Place 3" AC (3/4), 2" ARAC, .50" AR-ACFC. Tack coat between lifts.

Test Section 17 (ADOT 040617): Crack and seat existing PCC (4'x6'). Apply tack coat. Place 3" AC (3/4), 2" ARAC, .50" AR-ACFC. Tack coat between lifts.

Test Section 18 (ADOT 040618): Perform no preparation on existing surface. Apply tack coat. Place 3" AC (3/4), 2" ARAC, .50" AR-ACFC. Tack coat between lifts.

Test Section 19 (ADOT 040619): Rubblize existing PCC surface. Apply tack coat. Place 3" AC (3/4), 2" ARAC, .50" AR-ACFC. Tack coat between lifts.

Detail drawings of the required pavement repairs are shown in Figure 11, taken from the project construction plans.

The mix designs, materials, and construction details were specified by ADOT Standard Specifications for Road and Bridge Construction (Ref. 5), Special Provisions for the project IR-40-4(123) and an Addendum to the Special Provisions. Special Provisions and the Addendum appear in Appendix B. FNF Construction, Inc. was the lowest bidder.

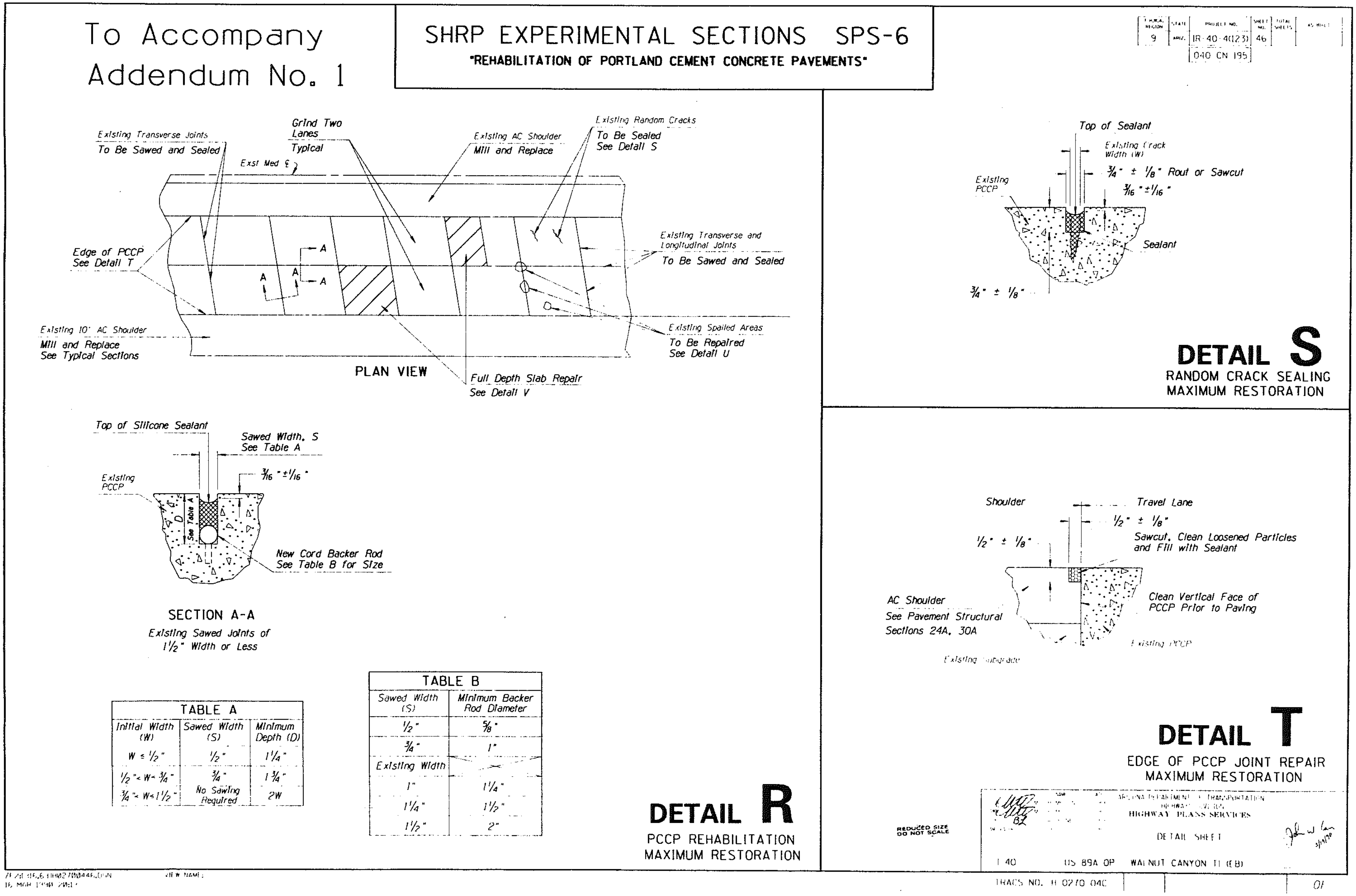


TABLE A

Initial Width (W)	Sawed Width (S)	Minimum Depth (D)
W ≤ 1/2"	1/2"	1 1/4"
1/2" < W < 3/4"	3/4"	1 3/4"
3/4" < W ≤ 1 1/2"	No Sawing Required	2W

TABLE B

Sawed Width (S)	Minimum Backer Rod Diameter
1/2"	5/8"
3/4"	1"
Existing Width	
1"	1 1/4"
1 1/4"	1 1/2"
1 1/2"	2"

FIGURE 11. PAVEMENT RESTORATION DETAILS

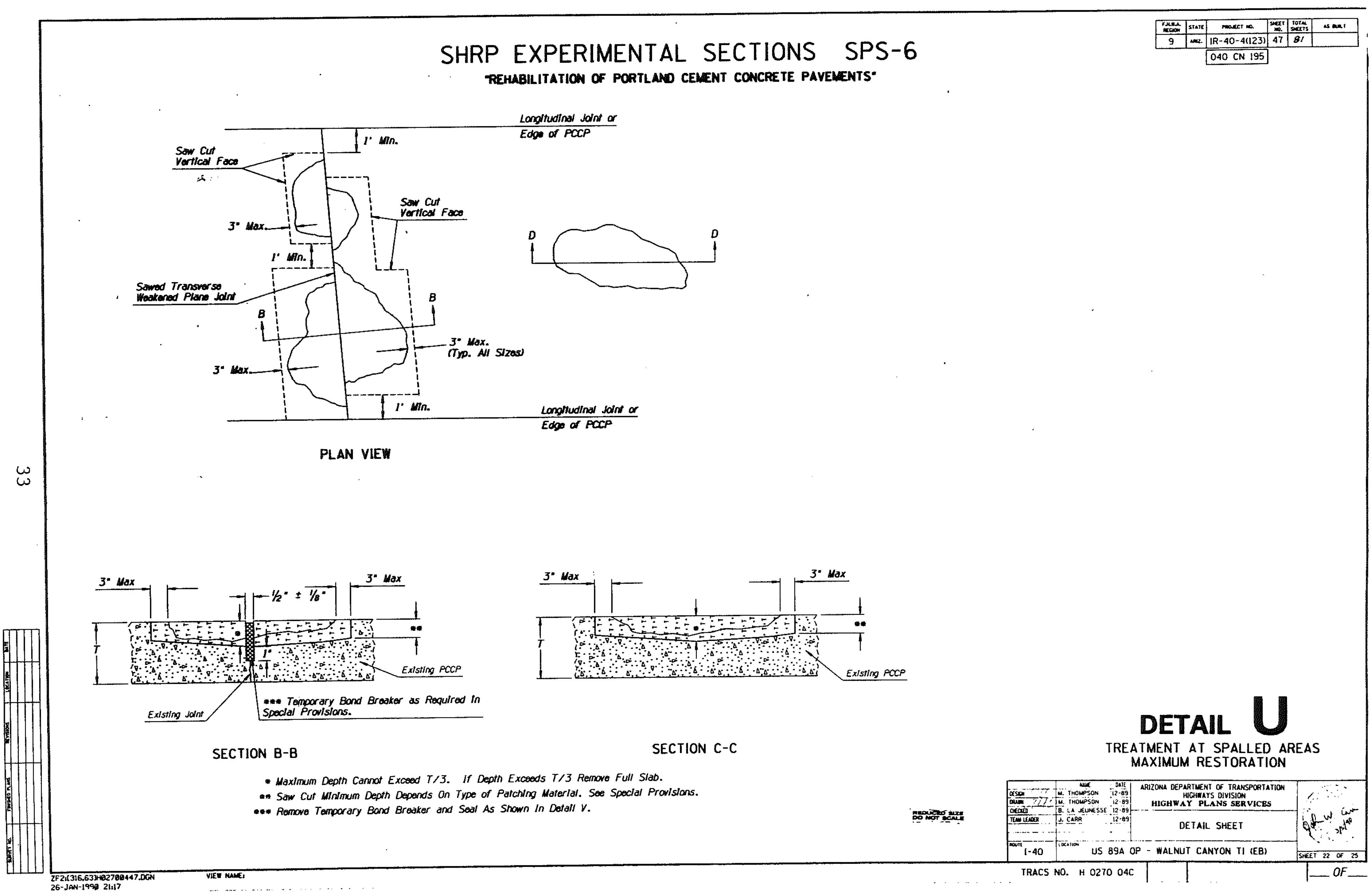


FIGURE 11. PAVEMENT RESTORATION DETAILS (continued)

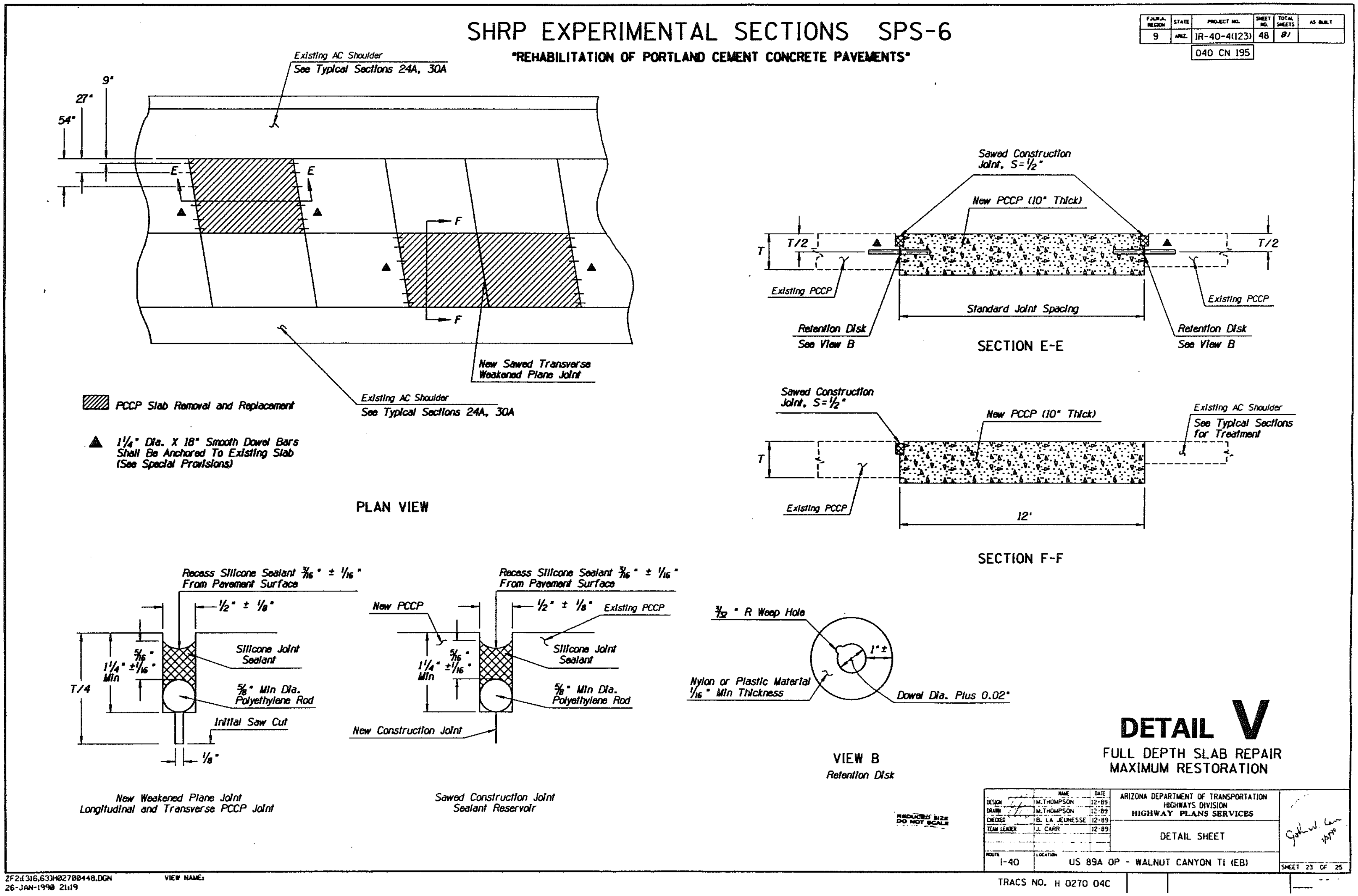


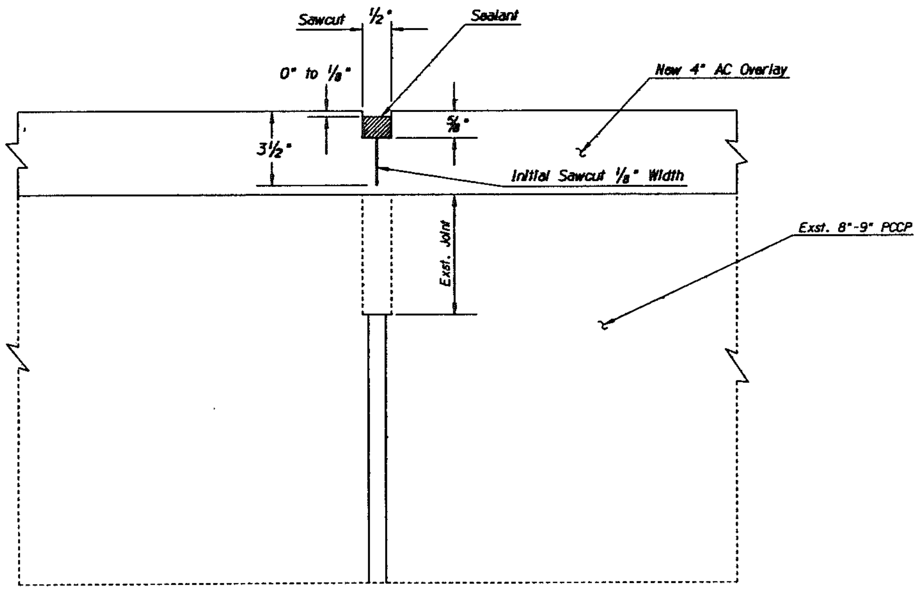
FIGURE 11. PAVEMENT RESTORATION DETAILS (continued)

SHRP EXPERIMENTAL SECTIONS SPS-6

"REHABILITATION OF PORTLAND CEMENT CONCRETE PAVEMENTS"

F.H.W.A. REGION	STATE	PROJECT NO.	SHEET NO.	TOTAL SHEETS	AS BUILT
9	ARIZ.	IR-40-4(123)	49	81	

040 CN 195



New Joints shall be constructed as follows:

1. *Over all transverse joints, full pavement width.*
2. *Over the longitudinal joint between travel lanes.*
3. *Over the longitudinal joint between right travel lane and 10' distress lane.*
4. *Over the longitudinal joint between left travel lane and 4' shoulder.*

DETAIL W

JOINT DETAIL IN AC OVERLAY
MAXIMUM RESTORATION

REDUCED SIZE DO NOT SCALE

	NAME	DATE
DESIGN	M. THOMPSON	12-89
DRAWN	M. THOMPSON	12-89
CHECKED	B. LA JEUNESSE	12-89
TEAM LEADER	J. CARR	12-89

ARIZONA DEPARTMENT OF TRANSPORTATION
HIGHWAYS DIVISION
HIGHWAY PLANS SERVICES

DETAIL SHEET
SHRP DETAIL W

ROUTE: I-40 LOCATION: US 89A OP - WALNUT CANYON TI (EB)

SHEET 24 OF 25

ZF2:[316,63]H02700449.DGN
26-JAN-1990 21:21
VIEW NAME:

TRACS NO. H 0270 04C

OF

FIGURE 11. PAVEMENT RESTORATION DETAILS (continued)

DISCUSSION OF SHRP DESIGN AND CONSTRUCTION GUIDELINES FOR TEST SECTIONS

The SHRP Guidelines for construction details, "Construction Guidelines for Experiment SPS-6 Rehabilitation of Jointed Portland Cement Concrete Pavements" as of July 1990, were followed as closely as possible in the construction. Appendix C includes a copy of this working document. The document provides specific guidelines for activities on the control section, pavement surface preparation before overlay, special considerations regarding test section construction, asphalt concrete mix design, construction operations, and deviations from guidelines.

TYPICAL SECTIONS

Eight test sections were designed by SHRP as shown in Table 1 in the Appendix C. The typical cross sections of the test sections in the guidelines were developed for the hypothetical existing pavement structure shown in Figures A-1 through A-8 in the guide. A part of the existing pavement section was designated as the "control" section as shown as Section No. 1 in Figure A-1 in the Appendix C. Details of the other test sections can be found in the guide.

ACTIVITIES ON CONTROL SECTION

Repairs and other activities on the control section were limited by SHRP to only routine maintenance needed to keep the section in a safe and functional condition. In general, the maintenance activities were required to be limited to those permitted in "Guidelines for Maintenance of General Pavement Studies (GPS) Test Sections," SHRP-LTPP-OM-001, July, 1988. Maintenance activities are to be performed in accordance with standard ADOT procedures.

PAVEMENT PREPARATION

The preparation of the existing pavement prior to overlay is classified in three levels: minimum restoration, maximum restoration, and crack and seat. PCC slab replacement is the most significant difference between the minimum and maximum preparation levels.

MINIMUM RESTORATION

The minimum level of pavement restoration activities include:

SHRP 040602	Perform joint and crack sealing, if warranted. Perform partial and full-depth patching, if warranted. Perform full surface diamond grinding, if warranted.
SHRP 040603	Perform partial and full-depth patching, if warranted.
SHRP 040604	Perform partial and full-depth patching, if warranted.

MAXIMUM RESTORATION

The maximum level of pavement restoration activities include:

SHRP 040605	Remove and replace existing joint and crack sealing. Perform additional joint and crack sealing, if warranted. Remove and replace existing partial and full-depth patches. Perform additional partial and full-depth patching, if warranted. Correct poor load transfer at joints and/or working cracks by full-depth patching or retrofitting dowels. Perform full surface diamond grinding. Retrofit subsurface edge drainage system. Perform undersealing, if warranted.

SHRP 040606	Remove and replace existing partial and full-depth patches. Perform additional partial and full-depth patching, if warranted. Correct poor load transfer at joints and/or working cracks by full-depth patching or retrofitting dowels. Retrofit subsurface edge drainage system. Perform undersealing, if warranted.

CRACK AND SEAT

Crack and seat preparation was scheduled for two test sections, as follows:

SHRP 040607	Crack and seat existing PCC Retrofit subsurface edge drainage system.
SHRP 040608	Crack and seat existing PCC. Retrofit subsurface edge drainage system.

SPECIAL CONSIDERATIONS

Lane widening and geotextiles were prohibited on the SHRP SPS-6 test sections. However, ADOT included a supplemental section with paving fabric. Surface friction courses were permitted but the thickness of the course was limited to O.75" or less. These prohibitions were stated because it was believed that they would confound the measurement of the main factor effects in the experiment.

ASPHALT CONCRETE MIX DESIGN

The design of asphalt concrete mixes was specified to be done in compliance with the guidelines contained in the FHWA Technical Advisory T5040.27. Only virgin materials are to be used. Recycled pavement should not be used. The quality of aggregates were expected to be highest quality and additional specifications were presented. The asphalt cement grade and characteristics were to be selected by ADOT based on normal practice. Additives routinely used by ADOT are permitted, but experimental additives or modifiers are prohibited.

CONSTRUCTION OPERATIONS

Construction guidelines were specified to be those in compliance with the guidelines presented in the FHWA Technical Advisory T5040.27 in conjunction with the high quality construction practice of the agency. Additional construction related guidelines were also outlined.

DEVIATION FROM GUIDELINES

No deviation from the guidelines was allowed, unless presented to and accepted by SHRP. Potential impact of non-compliance on the overall experiment must be evaluated by SHRP.

VI. EVALUATION OF EXISTING PAVEMENT

The existing section of pavement between mileposts 202.16 and 204.21 was evaluated to obtain information prior to construction of the test sections. Field investigations consisted of:

- Sampling and testing program
- Survey of cracking
- Deflection testing

Sample locations, deflection test point locations, and maps of the cracking are in Appendix D.

SAMPLING OF EXISTING PAVEMENT

Coring and drilling were completed on the existing pavement of the proposed SHRP SPS-6 test sections to retrieve samples of existing materials and to characterize them through laboratory testing. The sampling and testing plan was developed based on guidelines in SHRP Operational Memorandum No. SHRP-LTPP-OM-019, "Materials Sampling and Testing Requirements for Experiment SPS-6," January 1991 (Ref. 6).

Since the material sampling methods were destructive, they were planned close to, but outside the proposed test sections. The planned in-place material sampling and testing consisted of a combination of the following:

- 4" outside diameter cores of the original PCC surface layer. C-type cores.
- 6" outside diameter cores of PCC surface and treated layers. C-type cores.
- 6" outside diameter cores of PCC surface; augering of unbound granular base and subbase layers; split spoon sampling and/or thin-walled tube sampling as directed to 5' below top of subgrade. A-type cores/samples.

- 12" outside diameter cores of PCC surface; augering of unbound granular base, subbase layers and subgrade to 12" below top of untreated subgrade for bulk sample retrieval. BA-type cores/samples.

The plans followed in sampling are shown in Appendix D. The sample areas correspond to SHRP test sections as shown in Table 3. The sample locations are listed in Table 4. Stations are referenced to the beginning of each test section, which is 0+00.

SURVEY OF CRACKING

Films of the pavement were taken prior to construction of the test sections. Crack maps made from the film for the travel lane are in Appendix D. Data is available from only the eight SHRP sections. A summary of the distress is in Table 5.

TABLE 3. CORRESPONDENCE BETWEEN SAMPLE AREA AND SPS-6 TEST SECTIONS

Sample Area	SHRP ID	State ID
S1	040609	1
S2	040613	2
S3	040608	3
S4	040608	3
S5	040607	4
S6	040606	5
S7	040610	6
S8	040611	7
S9	040604	8
S10	040612	9
S11	040612	9
S12	040603	10
S13	040603	10
S14	040605	11
S15	040601	13
S16	040601	13

TABLE 4.

SPS-6 Preconstruction Sampling Locations

Section	Station	Offset	Core #
SHRP 040601 (SA S15)	-(0+05)	2	C30
	-(0+05)	3.5	C31
	-(0+05)	5	C32
SHRP 040601 (SA S16)	5+30	2	C33
	5+30	3.5	C34
	5+30	5	C35
	5+35	3	A12
SHRP 040603 (SA S12)	-(0+50)	2	C23
	-(0+50)	3.5	C24
	-(0+55)	5	A9
SHRP 040603 (SA S13)	10+30	3	A10
	10+35	3	C25
	10+35	6	C26
	10+40	3	BA10
	10+45	6	BA11
	10+50	3	BA12
SHRP 040604 (SA S9)	5+50	2	C17
	5+50	3.5	C18
	5+50	5	C19
SHRP 040605 (SA S14)	10+70	3	A11
	10+75	2	C27
	10+75	3.5	C28
	10+75	5	C29
SHRP 040606 (SA S6)	6+20	2	C12
SHRP 040607 (SA S5)	5+40	3	A5
	5+50	2	C9
	5+50	3.5	C10
	5+50	5	C11
SHRP 040608 (SA S3)	-(1+30)	3	A3
	-(1+35)	2	C5
	-(1+35)	3.5	C6
SHRP 040608 (SA S4)	5+45	2	C7
	5+45	3.5	C8
	5+50	3	A4
	5+55	3	BA1
	5+60	6	BA2
	5+65	3	BA3
SHRP 040609 (SA S1)	-(0+20)	2	C1
	-(0+20)	3.5	C2
	-(0+20)	5	C3
	-(0+25)	3	A1
SHRP 040610 (SA S7)	6+40	2	C13
	6+40	3.5	C14
SHRP 040611 (SA S8)	4+80	2	C15
	4+80	3.5	C16
	4+85	3	A6
	4+90	3	BA4
	4+95	6	BA5
	5+00	3	BA6
SHRP 040612 (SA S10)	-(0+50)	3.5	C20
	-(0+55)	3	A7
SHRP 040612 (SA S11)	5+54	2	C21
	5+54	3.5	C22
	5+60	3	A8
	5+65	3	BA7
	5+69	6	BA8
	5+75	3	BA9
SHRP 040613 (SA S2)	-(0+90)	2	C4
	-(0+95)	3	A2

TABLE 5. SUMMARY OF DISTRESS IN TRAVEL LANE PRIOR TO CONSTRUCTION OF TEST SECTIONS

SHRP ID	ADOT ID	No. of Slabs	% of Total Slabs with Distress	Joints with Spalling/Cracking %	Slabs with* Longitudinal/Transverse Cracking %	Shattered** Slabs %
040608	3	34	62	24	18	15
040607	4	34	64	35	32	6
040606	5	33	94	52	48	6
040604	8	32	84	50	38	19
040603	10	34	94	74	35	15
040605	11	33	94	70	33	3
040602	12	33	79	39	33	9
040601	13	34	82	59	38	6

*Slabs broken into two or less pieces

**Slabs broken into three or more pieces

VII. CHARACTERISTICS OF MATERIALS

Mix designs for some of the materials are included in Appendix E. Pertinent aspects of the designs are presented in this section of the report.

VIRGIN ASPHALT CONCRETE MIX (END PRODUCT) DESIGN

The mix design was a 3/4" asphalt concrete mix design performed by Speedie and Associates, Phoenix, Arizona, in June 1990. The samples of aggregate used in the design were obtained from stockpiles at Flagstaff Cinders, Coconino Cinders, and Winslow sand. The materials were designated as basalt coarse aggregate, basalt intermediate aggregate, basalt fine aggregate, Flagstaff cinders, Mahan concrete sand, and Winslow sand. The asphalt cement used was grade AC-20 supplied by Sahuaro Petroleum and Asphalt Company and produced at their Edgington refinery. The mineral admixture used was Type N hydrated lime supplied by Chemstar Lime. It was added wet to the mix at a rate of 1.5% by weight of the mineral aggregate. The material characteristics conform to those required in ADOT Standard Specifications for Road and Bridge Construction, edition of 1987 (5) and the special provisions of the project. Tables 6 and 7 show the properties and gradation of the aggregate.

The recommended bitumen content was found to be 4.6%. Table 8 shows the comparison between the required criteria of mix design and those obtained by design.

ASPHALT RUBBER ASPHALT CONCRETE (AR-AC) MIX DESIGN

The mix design for asphalt rubber asphalt concrete was done by the ADOT Central Materials Laboratory. The samples of aggregate used in the design were obtained from the Teepee Ready Mix pit in Casa Grande, Arizona. The materials were designated as a coarse aggregate, an intermediate aggregate and washed fine aggregate. Twenty percent granulated rubber of Type C 106 was used at a rate of 6.5% in the mix. The asphalt cement used was grade AC-10 supplied by SUNBELT refinery company and

TABLE 6. AGGREGATE PROPERTIES FOR 3/4" AC MIX

Property	Coarse	Fine	Combined	Specification
Bulk OD Sp Gr	2.768	2.639	2.703	2.35 - 2.85
SSD Sp Gr	2.815	2.675	2.744	
Apparent Sp Gr	2.903	2.738	2.819	
Absorption	1.678	1.358	1.517	0.00 - 2.50
Sand Equivalent			65	55 minimum
Plasticity Index			NP	
Crushed Faces			92	70 minimum
L.A. Abrasion "B":				
100 Rev. % Loss			5	9 maximum
500 Rev. % Loss				40 maximum
MATERIAL PERCENTAGES				
Basalt Fines	21.7			
Flagstaff Cinders	5.9			
Concrete Sand	0.0			
Winslow Sand	23.6			
Basalt Intermediate	9.9			
Basalt Coarse	37.4			
Admixture	1.5			

TABLE 7. GRADATION FOR 3/4" AC MIX

COMPOSITE GRADATION		
Sieve	% Passing	Spec Limits
1-1/2	100	100
1	100	100
3/4	95	85 - 95
1/2	78	
3/8	66	60 - 75
1/4	55	
#4	50	
#8	40	36 - 46
#10	39	
#16	33	
#30	24	
#40	18	11 - 19
#50	10	
#100	6	
#200	4.1	2.0 - 5.5

TABLE 8. MIX DESIGN CRITERIA (3/4" AC MIX)

Criteria	Required as per Specs	Achieved by Design
Voids in Mineral Aggregate (VMA, %)	14.5 - 17.0	14.5
Effective Air Voids (%)	5.5 ± 0.2	5.4
Index of Retained Strength (%, minimum)	70*	86
Wet Strength (psi, minimum)	150	542
Stability (lbs, minimum)	3000	4879
Flow (1/100")	8 - 16	12

*As per Special Provisions

produced at their Coolidge, Arizona plant. The mineral admixture used was lime supplied by Chemstar company. It was added to the mix at a rate of 1.0% by weight of the mineral aggregate. The specifications for materials characteristics conform to those required in ADOT Standard Specifications for Road and Bridge Construction, edition of 1987 (5), the special provisions and addendum to special provisions of the project. Tables 9 and 10 show the properties and gradation of the aggregate. Table 11 shows the properties of the mix achieved by the design.

ASPHALT CONCRETE FRICTION COURSE (ACFC)

The ACFC mix design was originated from ADOT Central Laboratory according to ADOT Spec 407. The design lab number is 89-450A, dated September 27, 1989. The aggregate proportions are as follows:

3/8"	90%
CR Fine	4%
W-Fine	6%

The aggregate source is United Metro Hill Pit, Commercial Pit No. CM0048. The asphalt cement is AC-20, supplied by Paramount Oil Co., and used in the mix at a rate of 6.8%. Aggregate properties and gradation are listed in Tables 12 and 13.

ASPHALT RUBBER ASPHALT CONCRETE FRICTION COURSE (AR-ACFC)

An AR-ACFC was added to ADOT Test Sections 14 through 19. Mix design information was not provided for inclusion in this report. However, one document indicated the adjusted bulk density was 130.6 lbs/CF.

TABLE 9. AGGREGATE PROPERTIES FOR ARAC

Property	Coarse	Fine	Combined	Specification*
Bulk OD Sp Gr	2.788	2.779	2.784	2.35 - 2.85
Water Absorption (%)			1.72	0.00 - 2.50
Sand Equivalent			95	55 minimum
Crushed Faces (%)			91	70 minimum
L.A. Abrasion:				
100 Rev. % Loss			6	9 maximum
500 Rev. % Loss			26	40 maximum

AGGREGATE PROPERTIONS

FNF 1/2" Chips	24%
FNF 3/8" Chips	12%
FNF Fines #1	21%
ACFC Chips	3%
B&B Intermediate	24%
B&B Washed Fines	16%

*As per addendum to special provisions

TABLE 10. AGGREGATE GRADATION FOR ARAC

Sieve Size	Gradation without Admixture	Gradation with Admixture	Gradation Specifications with Admixture
1/2"	100	100	100
3/8"	89	89	80 - 90
1/4"	57	57	40 - 60
#4	44	45	
#8	26	27	26 - 34
#10	22	23	
#16	14	15	
#30	9	10	
#40	8	9	5 - 15
#50	6	7	
#100	4	5	
#200	2.5	3.5	0 - 3.5

*As per addendum to Special Provisions

TABLE 11. MIX DESIGN PROPERTIES OF ASPHALT RUBBER ASPHALT CONCRETE (ARAC)

Property (with 6.5% AC-10/Rubber Mix)	Achieved by Design
Air Voids (%)	4.9
VMA (%)	18.1
Asphalt Absorption (%)	1.00
Bulk Density, pcf	151.6
Maximum Density, pcf	159.4
Stability (lbs, minimum)	2331
Flow (1/100")	18

TABLE 12. AGGREGATE PROPERTIES FOR ACFC

Property	Coarse	Fine	Combined
Specific Gravity	2.460	2.455	2.458
Water Absorption			2.81%
% Abrasion, 100 Rev.			7
% Abrasion, 500 Rev.			31
% Limestone			.20
Sand Equivalent			60
Flakiness Index			14
% Crushed Faces			100
Bulk Density, lbs/cu. ft.			122.4

TABLE 13. AGGREGATE GRADATION FOR ACFC

GRADATION (% PASSING)		
Sieve Size	Target Gradation	Gradation Band
1.5"		
1"		
3/4"		
1/2"		
3/8"	100	100
1/4"	68	
#4	36	35 - 55
#8	12	9 - 14
#10	11	
#16	8	
#30	6	
#40	5	
#50	4	
#100	3	
#200	2.1	0 - 2.5

PAVING FABRIC

The paving fabric used in Test Section No. 6 was Amopave 4597 Paving Fabric, manufactured by Amoco Fabrics and Fibers Company. Test results certified by Amoco are as follows:

Property	Minimum Roll Average Value	Special Provision Specifications
Grab Tensile, lbs.	120	100 minimum
Grab Elongation, %	50	40 minimum
Mullen Burst, psi	300	
Puncture, lbs.	90	
Trapezoid Tear, lbs.	45	
U.V. Resistance, % (strength retained)	70	
Asphalt Retention	.35	
Weight, oz/SY		5 to 8
Thickness		30 to 105 mils
Melting Point, °F		300 or greater

The asphalt binder used prior to placing the fabric was an AC-20 supplied by Sahuaro and applied at a rate of 0.19 gal/SY.

AGGREGATE TRENCH EDGE DRAIN

The aggregate trench edge drain consists of filter fabric, pipe, and aggregate. The filter fabric was Amoco CEF 4551 Geotextile Fabric, manufactured by Amoco Fabrics and Fibers company. Tests results were provided by Amoco as follows:

Property	Minimum Roll Average Value	Special Provision Specifications
Grab Tensile, lbs.	150	140
Grab Elongation, %	50	45 minimum 115 maximum
Mullen Burst, psi	350	220
Puncture, lbs.	90	50
Trapezoid Tear, lbs.	65	40
U.V. Resistance, % (strength retained)	70	70
EOS	70	50 - 100
Permittivity, (1/sec) gal/min/SF	.7 90	0.5

Pipe for the trenches was specified to be PVC 90° centigrade electric plastic conduit, EPC-40 or EPC-80.

The trench drain aggregate was from the Coconino Pit. Test results are as follows:

	Percent Passing			
Sieve Size	6/11 Sple.	6/15 Sple.	7/10 Sple.	Specifications
1-1/2"	100	100	100	100
1"	73	70	74	50 - 75
3/4"	47	40	42	
1/2"	30	18	21	20 - 50
3/8	22	9	13	
1/4"	12	2	5	
#4	9	1	3	0 - 15
#8	6	0.6	1	
#40	3	0.4	1	
#200	0.9	0.2	0.5	0 - 2.5
Bulk specific gravity				2.35 - 2.85
Water absorption				0 - 2.5
L.A. Abrasion at 500 revolutions				40% maximum

SPALL REPAIR MATERIAL

Spall repair and shallow depth patch material was specified to be CALTRANS Formula SET 45, a rapid-setting patch material. The design mix was stated to be one bag with 50% rock, producing a yield of 0.58 CF/bag.

1 bag SET 45

25 lbs. rock

= .58 CF/bag yield

Test results on the Tanner Plant aggregate used in the patching mix are as follows:

Sieve Size	Percent Passing 6/19 Sple.	Percent Passing 8/2 Sple.	Specifications
3/4"	100	100	100
1/2"	93	89	90 - 100
3/8"	52	41	40 - 70
1/4"	8	7	
#4	4	5	0 - 15
#8	2	3	0 - 5
#40		2	
#200		1	

CONCRETE FOR UNBONDED OVERLAY AND FULL-DEPTH REPAIRS

Concrete was specified to comply with ADOT specification 1006 and the project special provisions. Test reports on fine and coarse aggregates indicate the materials are from the Tanner Plant, Hayfield and Superior pits. The concrete for the full-depth repairs was supplied by the United Metro Plant, and the concrete for the unbonded overlay was supplied by the Tanner Plant. A Class P 4000 psi concrete was specified. Mix design for the full-depth repair concrete is as follows:

Material	Weight lbs/CY
Fly Ash (Class F)	102
Cement (Type II Low Alkali)	500
Sand	1184
Rock	1816
Water	283
Water Reducer (WRDA)	3 - 5 oz/CY
Air Entrainment (Micro Air)	1 - 3.5 oz/CY

Mix design for the unbonded overlay is the same as for the full-depth repairs, except that the water reducer amount is 4 oz/CY and the air entrainment is 2 oz/CY.

Concrete mix requirements are as follows:

Compressive Strength-28 day	- 4000 psi
Entrained air	- 4.0% to 7.0%
Slump	- 2.5" to 4.5"

The fine aggregate gradation is as follows:

Sieve No.	Percent Passing*	Specifications
3/8	100	100
4	100	95 - 100
8	86	
10	82	
16	65	45 - 80
30	42	
40	33	
50	20	0 - 30
100	8	0 - 10
200	2	0 - 4

*Approximate average of numerous tests

The coarse aggregate gradation is as follows:

Sieve No.	Percent Passing*	Specifications
1-1/2"	100	100
1"	100	95 - 100
3/4"	80	
1/2"	38	25 - 60
3/8"	12	
1/4"	2	
4	1	0 - 10
8	0.6	0 - 5
40	0.3	
200	0.1	0 - 1

*Approximate average of numerous tests

CONCRETE CURING MATERIAL

The concrete was cured with a white wax based curing compound supplied by Burke, with the following test results reported:

IR Scan: AZ 1574

Non-volatiles at 110°	-	25.7
Non-volatiles at 450°	-	4.6
Non-Vol-Vehicle	-	22.1

CONCRETE JOINT SEALANT

The joint sealant for concrete repairs was a silicone, Dow Corning 888, conforming to ADOT spec 1011-8, dated January 16, 1990. Test results are shown in Table 14. Dow Corning 888-SL was used for the joints in the unbonded PCC overlay.

CRACK AND EDGE SEALANT

Sealant for cracks and the edge between the asphalt shoulder and PCC was Crafco 231.

TABLE 14. SILICONE JOINT SEALANT, DOW CORNING 888, LOT NO. ET030082

Test	Test Method	Result	ADOT Sect. 1011-8 Material Requirements
*Tensile Stress: 150% Elongation (7-day cure), psi (average of 5)	ASTM D 412 (Method A Die C)	32.5	45 psi maximum
*Maximum Elongation at Failure, %	ASTM D 412 (Method A Die C)	**1116	700% minimum
Extrusion Rate, seconds	ASTM C 920 (Type S, Grade NS)	3	25 seconds maximum
Specific Gravity	ASTM D 792 (Method A)	1.496	1.15 to 1.515
Tack Free Time, minutes	ASTM C 679	37	120 minutes maximum
Durometer Hardness, Shore A (7-day cure at 50 ± 5% relative humidity)	ASTM D 2240	20	25 maximum
**Adhesion and Cohesion of Elastic Joint Sealants under Cyclic Movement	ASTM C 719 (Mortar Block)	No Cohesive Failure or Adhesion loss	±50%/-50% of joint width. Adhesive loss maximum 15% of surface area. No cohesive failure after 10 cycles at standard conditions.

*Sample was cured 7-days at 77 ± 2°F and 50 ± 5% relative humidity.

**Testing was conducted at 73.4 ± 3.6°F and 50 ± 5% relative humidity after the prescribed conditioning periods.

Results of the above testing indicates that the Silicone Joint Sealant Material, Lot. No. ET030082, meets the physical requirements as shown.

VIII. CONSTRUCTION OVERVIEW

SEQUENCE

The test sections were constructed between mid-June and mid-October of 1990. Work efforts from mid-June through the end of July concentrated primarily on the sections which were to receive minimum and maximum restoration, i.e., Sections 5, 8, 10, 11 and 12. The work consisted primarily of slab removal and replacement, spall repairs, and joint sealing. In addition, the trench drain was installed on these sections. Repairs and grinding on Sections 11 and 12 continued into late August. At the first of August, work started on rubblizing and crack-and-seat for Sections 1, 2, 3, 4, 6, 7, 9, 15, 16, 17 and 19. Asphalt paving followed-up immediately, with the bulk of the paving for all sections being completed from August 5 through August 12.

On September 12, milling of asphalt in the travel lane on Section 2 began in preparation for the unbonded PCC overlay. On September 24, the unbonded PCC was poured in the travel lane. The passing lane had previously been poured on September 4. Joint sawing and sealing continued on Section 2 until mid-October.

After the asphalt paving was completed, ADOT made a decision that placement of an ACFC was necessary on Test Sections 1, 3, 4, 5, 6,7, 8, 9 and 10 for the following reasons:

- Eliminate concern over a lack of frictional value through the test sections.

- Provide some pavement leveling through the length of the research section. Multiple variable thickness sections and tapers resulted in this reasoning.

- Provide sealing of areas where a marginal longitudinal joint was constructed and also areas where segregation of pavement aggregates was apparent.

The ACFC on these sections was placed in early October. Test Sections 14 through 19 received an AR-ACFC, which was already in production on the overall project. SHRP would not approve use of an AR-ACFC on Test Sections 1 through 13.

METHODS AND EQUIPMENT

The SHRP construction guidelines were followed and there were no significant deviations from the guidelines. Of the two sections which were to receive maximum restoration of the surface, i.e.,Sections 5 and 11, Section 11 received the most extensive repairs, including surface grinding. Section 5 received no surface grinding. The control section, Section 13, was also in a fairly deteriorated condition, and received slab replacements even though this was not originally planned. For the maximum restoration sections, SHRP/ADOT requested that an additional dowel bar be added in each wheel path, resulting in four 1-1/4" x 18" long epoxy coated dowel bars in each wheel path.

For the crack-and-seat sections, one pass of a guillotine type breaker was used, and seating was done with one pass of a 50 ton roller. The targeted crack pattern was 3' x 3' for Sections 2, 3 4, 6, 7 and 9, and 4' x 6' for ADOT's additional Sections 15 and 17.

For the rubblized sections a PB4 resonant pavement breaker was used. It made a series of longitudinal passes, 7" to 12" wide, breaking the pavement into 1" to 2" pieces with a steel shoe using a 2000 lb force applied at 44 times/minute. No seating was performed on the rubblized sections.

Some problems were encountered on Sections 1 and 16 as a result of the rubblizing operation. The vibratory nature of the rubblization process is believed to have caused liquefaction of the subgrade's fines which, in turn, caused upward water migration. The newly placed asphaltic concrete cracked severely, prompting the temporary closure of Interstate 40 eastbound. An emergency asphaltic concrete 3" overlay was performed by the Contractor on August 5. In addition, a 150' length of the pavement of the travel lane of Test Section No. 1 was excavated 4' to 7' deep and replaced with graded crushed rock and overlaid. The travel lane was later blade-layered to return it to a grade which allowed final lift placement. The remaining 350' of Section 1 received no excavation and repair, so it should comply with the requirements of the experiment.

The asphaltic concrete mix for the project was produced in a drum mixer plant and placed with a Blaw Knox PF200 paver in 12' lane widths. Breakdown rolling was accomplished with one pass of a 12.5 ton double drum vibratory roller and one pass of a 12.5 ton double drum static roller. Intermediate rolling was 4 passes of a pneumatic roller. Finish rolling was one pass of a 12.5 ton vibratory and 2 passes of a 12.5 ton static roller. Haul distance was 4 to 6 miles and haul time was approximately 15 minutes. The tack coat applied prior to paving was an SS-1H at 50% dilution, mixed 1 part diluent to 1 part asphalt. The application rate was 0.08 gal/SY.

Existing PCC pavement areas for partial depth patching and spall repair were determined by visual inspection. A diamond blade saw was used to cut the boundaries of repair areas. Deteriorated concrete was removed with 15 lb. chipping hammers. Final cleaning prior to placing the Set 45 patch material was accomplished by sand blasting followed by air blasting. Curing was accomplished with a membrane curing compound, supplemented by polyethylene sheeting if there was a threat of rain. A wooden float was used for finishing. Joints were formed with fiberboard inserts, and sealed with Crafco 231 rubberized sealant.

Existing PCC joints to be resealed were resawed if the width ≤ 3/4", but not if the width was between 3/4" and 1.5". If the joint width exceeded 1.5",it was treated as a spall. Joints were cleaned by sandblasting and air blasting. A backer rod was placed prior to sealing with Dow 888 silicone sealant.

Existing PCC cracks to be sealed were cleaned by routing, followed by air blasting just prior to placement of the sealant. No bondbreaker was placed in the crack.

Existing PCC areas to receive full-depth patching were determined visually based on the degree of cracking in the slab. A diamond blade saw was used to cut out the area to be removed and replaced. Typical depth of sawcut was 6". A pneumatic air hammer and backhoe mounted hoe ram were used to break-up the slab prior to removal. Load transfer dowels were installed and cemented with an epoxy filler material. Dowels were 1-1/4" diameter, 18" long, spaced at 14". They were epoxy coated.

Reinforcing steel was not placed in the full-depth patches. A standard concrete mix, as previously described, was poured. A roller tamp and roller-screed were used in consolidation and finishing.

Prior to placing the unbonded PCC overlay in Section 2, the asphalt was milled with a CAT PR-450. A standard ADOT concrete mix, as previously described, was poured. Joints were sawcut and sealed with DOW 888-SL silicone sealant.

QUALITY CONTROL OF MATERIALS

Tests run on the construction materials indicate they were generally in compliance with the specifications. Some of the test results are given on the following pages. Results of in-place density tests were not made available for this report.

Asphalt Paving Mix (3/4" End Product)

				Average Test Results (Average of 4 Samples)					
Property	UL	Target Value	LL	Aug. 4 Lot 40	Aug. 5 Lot 41	Aug. 10 Lot 42	Aug. 12 Lot 43/44	Aug. 12 Lot 43/44	Aug. 13 Lot 45/46
3/8"	75	66	57	64	61	62	63	62	61
8	46	40	34	41	36	38	41	40	36
40	22	18	14	20	18	20	21	21	18
200	6.3	4.1	1.9	5.6	5.2	4.3	4.6	4.7	4.5
% AC	5.2	4.6	4.0	4.7	4.5	4.9	4.7	4.7	4.9
% Air Voids	7.7	5.4	3.1	5.1	4.6	4.7	5.1	4.5	3.9
Stability	-	4000	3000	3284	3914	3621	3338	5573	3510
Bulk Density	-	-	-	152.1	153.7	151.9	151.2	152.4	153.8
Rice Density	-	-	-	160.2	161.2	159.3	159.4	159.6	160.1

Concrete for Full-Depth Repairs

Property	Specification	Average Test Result: ADOT Section 5 (3 Tests)	Average Test Result: ADOT Section 11 (10 Tests)
% Air Entrainment	4.0 - 7.0	5.2	5.3
Slump, in.	2.5 - 4.5	4.6	3.6
7-Day Comp. Strength, psi	-	3526 (5-day)	3723
28-Day Comp. Strength, psi	4000 min.	4436	4879

Concrete for Unbonded PCC Overlay

Property	Specification	Average Test Result: ADOT Section 2 (7 Tests)
% Air Entrainment	4.0 - 7.0	5.5
Slump, in.	2.5 - 4.5	3.6
7-Day Comp. Strength, psi	-	4067
28-Day Comp. Strength, psi	4000 min.	5180

Asphalt Rubber AC

Test results from samples taken on August 8, 9, 10 are as follows:

Location	% AC	Bulk Density, pcf	Stability	Flow
Passing Lane EB	6.54	144.9	2178, 1021	14, 13
SHRP Section 7	7.13	146.0		
SHRP Section 9	7.09	144.7		

The % AC was determined with a nuclear gauge.

IX. CONCLUSIONS

Design and construction of the SPS-6 test sections were successfully incorporated in ADOT construction project IR-40-4(123) on I-40 at Flagstaff. All features of the SHRP required SPS-6 experiment design were included in eight basic test sections. Design and construction data from these sections, along with future performance data that will be collected, will be a meaningful and important contribution to achieving the goals of the SPS-6 program.

In addition to the eight required SHRP sections, ADOT included eleven more test sections which were designed to incorporate features that are not in the SHRP SPS-6 experiment design. Continued study of these sections will provide valuable input to ADOT in its desires to develop the most effective and economical types of pavement design and construction for rehabilitation of jointed PCC pavements.

Construction of the test sections complied very closely with the preset SHRP and ADOT guidelines and no significant deviations were allowed nor experienced. Quality control of materials was good, with test results indicating that construction was in compliance with the specifications.

Overall, construction of the test sections was successfully completed, and each individual section properly represents its role in the SPS-6 experiment.

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APPENDIX A

SHRP Experiment Design

National Research Council

STRATEGIC HIGHWAY RESEARCH PROGRAM

SPECIFIC PAVEMENT STUDIES
EXPERIMENTAL DESIGN AND RESEARCH PLAN
FOR EXPERIMENT SPS-6
REHABILITATION OF JOINTED PORTLAND
CEMENT CONCRETE PAVEMENTS

STRATEGIC HIGHWAY RESEARCH PROGRAM
818 Connecticut Avenue NW
Washington, DC 20006

April 1989

Specific Pavement Studies
Experimental Design and Research Plan
for Experiment SPS-6
Rehabilitation of Jointed Portland Cement Concrete Pavements

INTRODUCTION

The studies of rehabilitation and overlay techniques were the strongest contenders for inclusion in Specific Pavement Studies (SPS) as determined by previous balloting of highway agencies. Participation in and support of the research plans by the state and provincial highway agencies indicates enthusiasm for early implementation of the plan. Successful completion of the research project SPS-5 "Rehabilitation of Asphalt Concrete Pavements" and the research project SPS-6 "Rehabilitation of Jointed Portland Cement Concrete Pavements" will make major contributions to our ability to increase the life of the existing primary highway system of the United States and Canada through proper use of rehabilitation and overlay techniques.

The experimental designs and research plans presented here for SPS-6 were adapted from the Specific Pavement Studies on restoration of jointed concrete pavements (JCP) and pretreated JCP with AC overlay originally described in the May 1986 Strategic Highway Research Program Research Plans issued by the Transportation Research Board. Some of the original experimental design factors have been revised based on state and province desires and budget limitations. The plan has been prepared by the SHRP in cooperation with state and provincial highway agency personnel participating in various meetings including an SPS-6 workshop held in Washington, D.C., February 28 - March 1, 1989. The recommendations of the participants from 25 states and provinces and FHWA are incorporated into the experimental design and research plan described in this report. This research plan will be used by highway agencies and SHRP as a guide for selecting candidate projects to be considered for inclusion in the SPS-6 experiment and for design and construction of the test sections.

PROBLEM STATEMENT

Many United States and Canadian highway agencies are faced with the difficult task of determining the best way to treat existing aging and deteriorating jointed concrete pavements. Not only must they determine which rehabilitation procedures work best under which circumstances, but they must also determine the most appropriate time to apply such rehabilitation treatments. The problem is further complicated by the need to address an entire network of pavements at various levels of condition and age with limited funding resources.

There are a variety of rehabilitation techniques that can be applied to jointed concrete pavements (JCP) to restore condition and extend service life. These techniques involve a combination of levels and types of pavement preparation with and without the application of asphalt concrete (AC) overlays.

Pavement preparation approaches range from minimal treatment of the original PCC pavement to full "Concrete Pavement Restoration" (CPR) as well as cracking/breaking and seating. Pavement preparation can include diamond grinding, subsealing, full-depth repair, partial-depth spall repair, restoration of load transfer, resealing of transverse joints, resealing of longitudinal lane/shoulder joints, pressure relief joints, retrofit tied PCC concrete shoulders, and longitudinal subdrains. Depending on the extent and type of pavement preparation, asphalt concrete overlays of appropriate thicknesses may or may not be applied.

The long term performance of such rehabilitated pavements has not been systematically monitored and evaluated. There are no analytical design procedures for PCC rehabilitation and there are many unanswered questions regarding the appropriate rehabilitation techniques to use for a given pavement condition, traffic level, and climate as well as the proper timing of rehabilitation treatments.

One of the major LTPP objectives is "To Develop Improved Design Methodologies and Strategies for the Rehabilitation of Existing Pavements." A generally accepted approach for making cost effective decisions on pavement maintenance and rehabilitation is the use of pavement management concepts including life-cycle cost analyses of construction and rehabilitation activities. The ability to predict the performance and life expectancy of various rehabilitation strategies, with and without overlays, is essential to pavement management and life-cycle cost analyses. Consequently, the development of improved performance predictions models for various rehabilitation strategies is essential to achieving the LTPP objectives and should be one of the early products of research.

OBJECTIVE

The objective of this study is to develop improved performance prediction models to be used for determining the additional pavement life that can be expected from the application of a variety of JPC and JRC pavement rehabilitation methods and strategies ranging from minimal to maximum investment in the rehabilitation treatment. The treatments being studied include combinations of surface preparations, with and without AC overlay, as well as crack and seat preparation with AC overlay. The study objective includes a determination of the influence of environmental region and initial pavement condition on the effectiveness of rehabilitation methods. Accomplishing this objective will provide substantially improved "tools" for use in pavement management and life-cycle cost analysis activities.

PRODUCTS

One of the primary specific products of this portion of SHRP LTPP research will be to evaluate and improve portions of the AASHTO Guide for Design of Pavement Structures that pertain to pavement rehabilitation design methods, life-cycle cost analysis, and pavement management. The SPS-5 and SPS-6 experiments will provide uniform and structured field performance data upon which "Part III - Pavement Design Procedures for Rehabilitation of Existing Pavements" and sections on pavement management and life-cycle cost analysis of the AASHTO Guide can be evaluated and improved. These products are a direct response to the first two objectives of the LTPP program, which are 1) to evaluate existing pavement design procedures and 2) develop improved pavement rehabilitation design methods and strategies.

The structural overlay method for rehabilitation of existing pavements that is included in the AASHTO Guide is based on a thickness or structural deficient approach that presumes the existing pavement is structurally inadequate for anticipated future traffic and climactic conditions. This experiment will provide means for the field verification of this design approach. In addition, these AASHTO design procedures are not applicable to non-structural deficiencies and other functional rehabilitation needs. However, these factors will be considered in this experiment.

This study will produce data concerning JPC and JRC pavement performance and extended life predictions, including the relative cost effectiveness of various rehabilitation methods and strategies, ranging from minimum restoration to extensive concrete pavement restoration with and without AC overlays plus crack/break and seat with AC overlay.

The key products from the proposed study will include the following:

1. Comparisons and development of empirical prediction models for performance of JPC and JRC pavements with different methods of surface preparation, with and without AC overlays, with sawed and sealed joints, and with crack/break and seat preparation and different AC overlay thickness.

2. Evaluation and field verification of the AASHTO Guide design procedures for rehabilitation of existing JPC and JRC pavements with and without AC overlay, and other analytical overlay design procedures for JPC and JRC pavements.

3. Determination of appropriate timing to rehabilitate JPC and JRC pavement in relation to existing condition and type of rehabilitation procedures.

4. Development of procedures to verify and update the pavement management and life-cycle cost concepts in the AASHTO Guide using the performance prediction models developed for rehabilitated JPC and JRC pavements.

5. Development of a comprehensive data base on the performance of rehabilitated jointed concrete pavements for used by state and provincial engineers and other researchers.

BENEFITS TO PARTICIPATING HIGHWAY AGENCIES

This experiment will provide the states and provinces with actual data on the cost and performance of alternative methods for portland cement concrete pavement rehabilitation. These data are necessary for the accurate use of pavement management systems including life-cycle cost analysis and predictions. In addition to these direct benefits, participating highway agencies will receive ancillary benefits as a result of direct involvement in the experiment. For example, the interactions between agency's personnel are the SHRP staff, contract researchers, and highway personnel from other agencies will produce valuable insights and exchange of ideas.

To evaluate innovative rehabilitation designs and local practices, sponsoring states and provinces can construct additional test sections on or near the SPS experiment projects containing factors of special interest. For example, an agency interested in evaluating the performance of a proprietary product such as geo-fabric to reduce reflective cracking, could construct additional test sections along with the SPS experiment test sections. SHRP will assist with the design, data collection, and performance evaluation of such experiments and will provide coordination for desired regional or partial experiments.

Another primary benefit to participating highway agencies is that a portion of the research will be conducted on the specific pavements and construction practices employed by the participating highway agency, allowing direct use of the results. Having test sections within a jurisdiction provides the opportunity to link performance measurements based on the local pavement evaluation techniques directly to the national pavement data base being developed by SHRP. For example, highway agencies using a Dynaflect or Roadrater deflection measurement device can develop correlations with the falling weight deflectometer measurements performed using SHRP equipment.

EXPERIMENTAL DESIGN

The recommended experimental design is shown in Table 1. It identifies the primary experimental factors and their relationships with each other. Table 1 identifies site related factors across the top and rehabilitation treatments down the side. Each column in this arrangement represents either one or two project locations each of which incorporates several test sections. Each row represents a series of test sections with specific features to be constructed at each project location.

This experimental design is a coordinated research plan intended to produce data and performance information for a variety of rehabilitation and overlay procedures constructed to extend the life of existing jointed PCC pavements. The primary factors being studied are: (1) the extent of preparation and restoration of the existing pavement, (2) thickness of AC overlay, and (3) environmental (climatic) factors. Other considerations are: (1) existing condition of pavement, (2) pavement type, (3) subgrade soil, and (4) traffic volume and load. In addition, the experiment will include other test sections desired by the highway agency to evaluate local practices or innovative features.

SHRP fully recognizes that no agency is able to continue in service any test section, even for research purposes, that becomes unsafe or disruptive to traffic flow. When in the judgment of the highway agency, a test section reaches such a condition, it should be treated as considered appropriate by the state or provincial highway agency. Such sections will be removed from the study and SHRP will endeavor to obtain final condition data prior to their treatments by the highway agency.

Site Related Factors

Site related factors include two pavement types (jointed plain concrete and jointed reinforced concrete) in both fair and poor conditions in three climatic regions (wet-freeze, wet-no freeze, and dry-freeze), and one pavement type (jointed plain concrete) in both fair and poor condition in the fourth climatic region (dry-no freeze). Jointed Reinforced Concrete pavement type is not a

Table 1. Experimental design for SPS-6, rehabilitation of jointed portland cement concrete pavements.

Rehabilitation Procedures \ Factors for Moisture, Temperature, Pavement Type, and Pavement Condition		WET FREEZE				WET, NO FREEZE				DRY FREEZE				DRY, NO FREEZE	
		JPCP		JRCP		JPCP		JRCP		JPCP		JRCP		JPCP	
		FAIR	POOR	FAIR	POOR	FAIR	POOR	FAIR	POOR	FAIR	POOR	FAIR	POOR	FAIR	POOR
PREPARATION	OVERLAY THICKNESS														
Routine Maintenance (Control)	0	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	x	x	x	x
Minimum Restoration	0	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	x	x	x	x
	4"	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	x	x	x	x
	4" *	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	x	x	x	x
Maximum Restoration (CPR)	0	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	x	x	x	x
	4"	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	x	x	x	x
Crack/Break and Seat	4"	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	x	x	x	x
	8"	xx	xx	xx	xx	xx	xx	xx	xx	xx	xx	x	x	x	x

* with saw AC overlay joints above JCP joints and seal

Subgrade Soil: Fine
Traffic: >200 KESAL/Year

Each "x" designates a test section.

study factor in the dry-no freeze region because it is not frequently built in this region.

These levels of climatic regions, pavement types, and pavement condition study factors will result in fourteen different study combinations. In addition, each test section, with the exception of JRC pavements in the dry-freeze and JPC pavements in the dry-no freeze climatic regions will be replicated. Thus, twenty-four project sites are needed for this experiment. Where ever possible, replication will take place in different jurisdictions to allow a greater range of practices to be studied.

Climatic Factors

The climatic regions are, for the most part the same as the environmental zones used in the General Pavement Studies (GPS) except they are not modified to correspond with state boundaries. Climatological factors at specific locations will be used for selection of SPS projects. For example, in this experiment a project in the south east portion of Kansas could fall in the wet-freeze climatic zone rather than in the dry-freeze zone as indicated on the GPS environmental zone map.

Wet climatic regions are considered to have a high potential for moisture presence in the entire pavement structure throughout most of the year. Dry climatic regions are considered to have very little and low seasonal fluctuation of moisture in the pavement structure. Freeze regions include locations with severe winters that result in long-term freezing of the subgrade. No freeze climatic regions are considered to have no long-term freezing of subgrade.

Pavement Type Factors

The two pavement types considered in this experiment are JPCP and JRCP. Although there are a wide range of joint spacings in existing pavements, no specific criteria has been established in this regard for the selection of projects to be included in this experiment. This factor will be given further consideration when candidate projects are being reviewed for final selection.

Pavement Condition Factors

The classification of existing pavement condition as fair or poor will be used primarily to screen candidate projects to provide a range of existing distress conditions. Distress condition surveys of all test sections will be made prior to rehabilitation to provide information for the data base. However, it is desirable to have some type of composite distress index be used by highway agencies to classify pavement condition when selecting projects for submittal to SHRP as candidates for the study. In view of the desire to immediately identify candidate projects for the 1989 construction season, agencies are urged to select projects that they classify as in fair or poor condition and provide details on the procedures used for such classification. This information will be used by the SHRP to further develop distress index classification procedures for use in selecting the remaining candidate projects for the 1990 construction season.

A structural based classification of present pavement condition will be used rather than roughness, ride quality, or skid resistance because these conditions are normally corrected by placement of thin overlays. The rehabilitation procedures being studied are intended to overcome structural inadequacy. The types of distress to be included in the classification include faulting, patching, spalling, pumping, joint deterioration, and slab cracking. The distress index will consider the extent and severity of each distress type. Although several types and degrees of distress may occur in a project, all test sections in a project are to be either in fair or poor condition and as the result of the same type of distress.

Other Site Factors

Other factors that contribute to pavement performance which are not included as study factors, will be considered in the test site selection process to keep the experiment within a practical implementable size.

This experimental design is intended for projects built on fine grained subgrade types and for traffic levels above 200 KESAL per year (per outside lane) because they represent the situation of greatest concern and provide a sterner test of rehabilitation strategies. If project sites meeting these criteria cannot be found, lower traffic levels and/or coarse grained subgrade types will be considered. However, all test sections in a site should have the same type of subgrade soil and traffic.

The proposed experimental design further constrains other factors through the site selection process as follows:

1. Performance period - Because quantification of the existing pavement condition is not possible for previously overlayed pavements, all test sections are to be located on pavements in their first performance period (i.e. no prior overlay). A section can be considered if a thin overlay or maintenance surface patch has been placed but will be removed prior to the rehabilitation and the current condition of the JCP can be determined. Existing open graded friction courses should be removed by milling if the pavement is to be considered as a candidate project. The addition of an open graded friction course to the new overlay for safety and/or agency policy requirements is allowed, but should not be considered part of the structural overlay thickness.

2. Pavement age - All projects should have been completed between 1965 and 1978 to avoid excessively young or old pavements and unusual performance.

3. Pavement thickness - All pavements shall be 8" to 10" thickness over a minimum of 3" stabilized or unstabilized subbase.

4. Project uniformity - All test sections in a project should have the same design details, materials, construction quality and should experience uniform traffic movement.

Pavement Preparation

Three levels of pavement preparation plus routine maintenance as a control section will be applied to the test sections prior to AC overlay. They are minimal restoration, intensive CPR, and crack/break and seat. Routine maintenance will consist of joint and crack sealing and limited patching.

The minimal restoration level will consist of routine maintenance including limited patching (filling pot holes), crack repair and sealing, and stabilization of joints. This level is typical of the current practice of many highway agencies prior to overlay.

The intensive CPR level will consist of several activities that will be done depending on pavement distress and condition. This intensive level represents a premium level of pavement preparation addressing grinding, subsealing, subdrainage, joint repair and sealing, full depth patching with restoration of load transfer, and shoulder rehabilitation. Surface grinding and joint and crack sealing will not be performed on test sections that will receive an AC overlay.

Due to the possible variation in existing pavement condition, 1,000 foot long test sections are recommended for the study of the minimum restoration and intensive CPR sections without an AC overlay.

Crack/break and seat is the process of using mechanical means to reduce slab size to minimize or eliminate reflective cracking in the asphalt concrete overlay. Crack and seat is the process used with plain (unreinforced) concrete pavement and break and seat is the process used with jointed reinforced concrete pavements. The cracking and breaking procedures need to be uniformly applied to their respective pavement types. The seating procedures also need to be controlled to ensure seating of the cracked or broken slabs.

If desired by the participating highway agency, additional sections incorporating other types of pavement preparation will be evaluated. These sections may include crack and seat with different crack spacing, rubblized pavements, or other features.

Overlay Factors

The study design includes three overlay thicknesses, (0, 4, and 8 inches). No overlay will be used on the control section and one each of the test sections that will receive minimum restoration and intensive CPR pavement preparation. The 4-inch thick overlays will be used on the test sections receiving the minimal restoration level of pavement preparation, the intensive CPR level of pavement preparation, and the crack/break and seat pavement preparation. The 8-inch thick overlay will be used on a test section that will involve crack/break and seat. In addition, a 4-inch overlay in which joints are sawed above the existing joints and then sealed will be applied to test sections receiving the minimum restoration treatment.

The overlays allowed for use on the test sections will be further constrained to insure a reasonable level of consistency as follows:

1. All overlays use virgin materials.
2. The application will not incorporate SAMI or any type of reinforcement (fibers, geotextiles, etc.).

If desired by the participating highway agency, additional sections incorporating other types of overlay design will be evaluated. These sections may include AC overlays with different thickness, portland cement concrete overlays, use of fabrics or fibers, or other features.

AC Mix Design

Problems will likely to develop if an agency or a contractor is required to design or build test sections that vary substantially from the normal practice and experience. For this reason, a standard AC overlay mix design is not required. However, to produce reasonably consistent mixes for the AC overlays using local materials and design procedures, the FHWA Technical Advisory T5040.27, "Asphalt Concrete Mix Design and Field Control" dated March 10, 1988 shall be used as a guide by the state and provincial highway agencies. This Advisory contains detailed recommendations for material selection, mix design, plant operation, and compaction.

TEST SECTION SEQUENCE

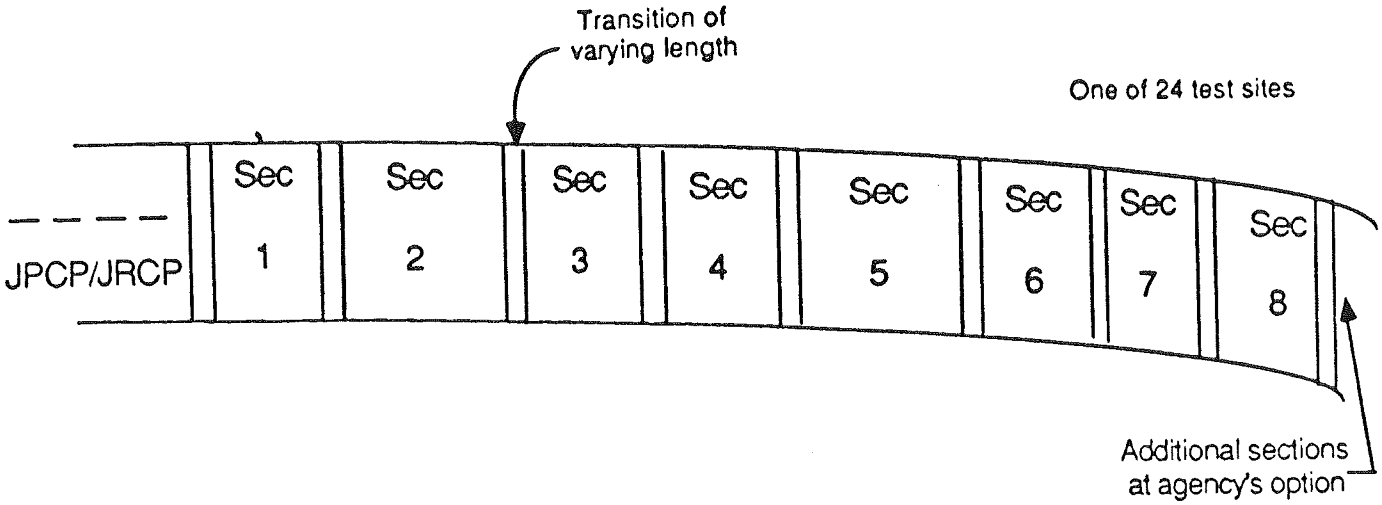
The sequence of sections depicted in Figure 1 are not random. They are organized based on construction considerations. It places test sections with similar pavement preparation levels adjacent to each other and minimizes abrupt changes in asphalt concrete overlay thicknesses. Under this approach the overlay thickness can be gradually modified over the transition area.

The sequence shown in Figure 1 is not fixed and may be varied to accommodate local construction conditions. Each test section will be 500 feet in length with the exception of the test sections that receive minimum restoration and full CPR preparation and no asphalt concrete overlay. These test sections will be 1,000 feet long. The sections will be separated by an appropriate transition length to meet practical construction considerations. Transition section length will vary based on site condition to assure cohesive test sections.

To help reduce the effort in identifying potential test sites for this experiment, several sources can be used. These include the agency's list of projects scheduled for rehabilitation, projects identified as candidates for GPS-7B, "New AC Overlay on Portland Cement Concrete Pavements", and projects in GPS-3, "Jointed Plain Concrete Pavement", and GPS-4, "Jointed Reinforced Concrete Pavement" that warrant rehabilitation. The use of GPS candidate projects will result in a reduced data collection effort.

CONSTRUCTION CONSIDERATIONS

Construction problems and variations as well as environmental conditions during construction could influence the performance of test sections to a greater extent than the design factors. Because construction procedures and control will be the responsibility of the many participating agencies, accurate records of actual construction procedures must be obtained (references to construction



SPS-6 SECTION	JC PAVEMENT PREPARATION	OTHER TREATMENTS	OVERLAY THICKNESS
1	Routine Maintenance		0
2	Minimum Restoration		0
3	Minimum Restoration		4-inch
4	Minimum Restoration	Saw and seal joints in AC	4-inch
5	Maximum Restoration (CPR)		0
6	Maximum Restoration (CPR)		4-inch
7	Crack/Break and Seat		4-inch
8	Crack/Break and Seat		8-inch

Figure 1. Illustrative Test Section Layout for SPS-6, Rehabilitation of Jointed Portland Cement Concrete Pavements.

specifications will not be adequate). In addition, records must be maintained of weather conditions and events such as equipment breakdowns and material contamination during the test section construction. Testing during construction of the AC overlays will be required to encourage as much uniformity as possible. Guidelines will be developed to cover such items as compaction and air voids content, profile or roughness specifications for the finished overlay, and minimum sampling and testing for quality assurance and control. Field experience gained during the initial projects completed in 1989 will be used to develop these guidelines.

Breaking the JRCP requires a considerably higher effort than cracking JPCP. For uniformity during cracking and breaking, guillotine hammer or pile driver equipment should be used. Crack spacing should be 3 feet by 6 feet for JPCP and 18 inches for JRCP. Tests should be performed to ensure full depth cracking. A minimum 30 ton roller should be used for seating, and field tests should be performed to determine the rolling pattern required to achieve proposed crack pattern and pavement seating. Test sections should receive the AC overlay as soon as possible after seating.

Although the test sections to be monitored are limited to the outside lane in one direction, it is desirable that all rehabilitation preparation activities and overlays be extended the full width of the pavement. Also to ensure uniformity, it is required that all test sections in each site be completed in one construction season.

Arrangements will be made for the collection of AC overlay samples for later testing by SHRP.

PARTICIPATING AGENCY RESPONSIBILITIES

Participating highway agencies will play the major role in the development and conduct of the Specific Pavement Studies, including the following activities:

- Participation in experimental design and implementation plans.
- Nomination of test sites.
- Preparation of plans and specifications.

- Selection of construction contractor.
- Construction of the test pavements.
- Construction inspection and management.
- Provision of traffic control for all test site data collection.
- Routine material sampling.
- Collection and reporting of pavement inventory data.
- Collecting periodic skid resistance measurements.
- Conducting and reporting maintenance activities.
- Collection and reporting of traffic and load data.

SHRP RESPONSIBILITIES

SHRP responsibilities will include the following:

- Development of the experimental design.
- Coordination among participating highway agencies.
- Final acceptance of test sites.
- Development of standard data collection forms.
- Assistance with special sampling requirements.
- Coordination of materials sampling and testing.
- Monitoring of pavement performance.
- Development of a comprehensive data base and data entry.
- Control of data quality.
- Data analysis and reporting.

IMPLEMENTATION AND SCHEDULE

This SPS-6 research plan and experimental design is ready for implementation. However, development was an evolutionary process and change is likely to continue with detailed adjustments as experience is gained from early projects.

Step one of implementation is the identification and submission by highway agencies of candidate projects for possible inclusion in the study. A total of 24 projects will be required to complete the experiment as planned. SHRP desires to select and construct test sections in at least 2 or 3 projects during the

1989 construction season. The remaining sections will be selected from the identified candidates and constructed in 1990. SHRP will assist the highway agencies in identifying candidate projects.

The existing condition of the test sections; in terms of distress, profile, deflections, and material characteristics; must be assessed prior to the rehabilitation and overlay activities. This will require extensive coordination between SHRP staff and regional offices, and the highway agencies. Traffic data must be collected at each site using WIM equipment. It will be desirable to install the WIM equipment at the time of rehabilitation work but, if this is not possible, it should be installed within a year of construction.

The proposed schedule of activities for this experiment is as follows:

Nomination of Candidate Projects:	
- For 1989 Construction Season	April 30, 1989
- For 1990 Construction Season	May 30, 1989
Review and Screening of Candidate Projects	As received
Notification of State/Provinces of Accepted Projects	
- For 1989 Construction Season	June 1, 1989
- For 1990 Construction Season	July 15, 1989
Supplementary Recruitment Activities (with individual agencies)	As needed
Implementation Workshop with Participating Agencies	
- For 1989 Construction Season (with individual agencies)	As required by Participating Agency
- For 1990 Construction Season	Mid-August 1989